

**Conseil général des pêches
pour la Méditerranée (CGPM)**

**General Fisheries Council
for the Mediterranean (GFCM)**

Rapport de la

**TROISIÈME CONSULTATION TECHNIQUE
SUR L'ÉVALUATION DES STOCKS
DANS L'ADRIATIQUE**

Report of the

**THIRD TECHNICAL CONSULTATION
ON STOCK ASSESSMENT
IN THE ADRIATIC**

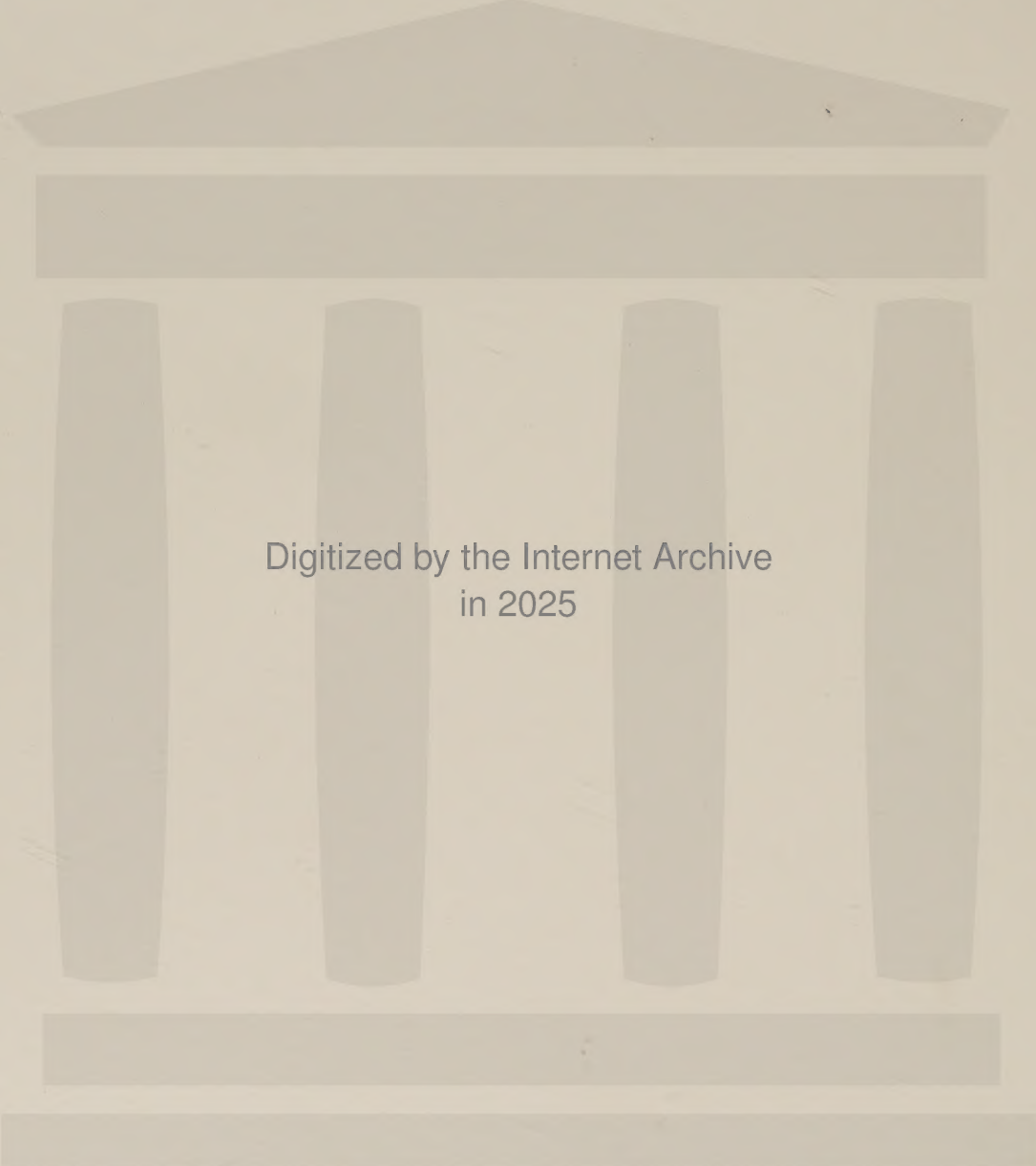
Fano, Italie/Italy, 6-10 juin/June 1983



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CONSEIL GENERAL DES PECHEES POUR LA MEDITERRANEE (CGPM)
GENERAL FISHERIES COUNCIL FOR THE MEDITERRANEAN (GFCM)

RAPPORT DE LA TROISIEME CONSULTATION TECHNIQUE
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ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome 1984

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M-43

ISBN 92-5-002084-8

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PREPARATION DU PRESENT RAPPORT

Le présent texte constitue la version définitive du rapport que la Consultation technique sur l'évaluation des stocks dans l'Adriatique a approuvé à sa troisième session.

PREPARATION OF THE PRESENT REPORT

The present text is the final version of the report approved by the Technical Consultation on Stock Assessment in the Adriatic at its Third Session.

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FAO/FAO Regional Fishery Officers

La référence bibliographique de ce document doit
être donnée ainsi/For bibliographic purposes this
document should be cited as follows:

CGPM/GFCM, 1984, Rapport de la troisième Consultation
technique sur l'évaluation des
stocks dans l'Adriatique. Report of
the third Technical consultation on
stock assessment in the Adriatic.
Fano, Italie/Italy, 6-10 juin/June
1983. FAO Rapp.Pêches/FAO Fish.Rep.,
(290):255 p.

RESUME

La réunion a fourni l'occasion de passer en revue les progrès réalisés, au niveau sous-régional, dans les domaines de l'évaluation des ressources et de la définition des mesures d'aménagement dans l'Adriatique. Les sujets principaux abordés ont été les suivants: prospections par chalutage, prospections acoustiques, évaluations par la méthode des oeufs et des larves, collecte des statistiques de pêche, niveau d'exploitation des petites espèces pélagiques. Les progrès accomplis dans les domaines d'action recommandés lors de la deuxième Consultation technique ont été examinés. Des solutions de nature à résoudre les difficultés rencontrées ont été proposées et un nouveau catalogue des travaux à accomplir pendant l'intersession a été établi.

ABSTRACT

The meeting provided an opportunity to review progress attained at the sub-regional level in the fields of resource assessment and establishment of management measures in the Adriatic. Major topics considered were: trawl surveys; acoustic surveys; assessments through the egg and larvae method; fishery statistics collection; small pelagic species exploitation level. The progress reached in the fields of action recommended at the second Technical Consultation was examined. The kind of solutions that could solve the difficulties encountered were proposed and a new list of work to be done during the interim between sessions was prepared.

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I. INTRODUCTION

1. La troisième Consultation technique sur l'évaluation des stocks dans l'Adriatique s'est tenue à Fano du 6 au 10 juin 1983, à l'aimable invitation du Gouvernement italien.

2. M. D. Charbonnier, Secrétaire du CGPM, a ouvert la réunion et remercié au nom de la FAO les autorités locales et en particulier M. C. Piccinetti, Directeur du Laboratoire de biologie marine et des pêches de Fano, des dispositions prises pour faciliter les travaux de la réunion. Il a souligné l'intérêt que ces consultations sous-régionales suscitent parmi les chercheurs qui y participent et rappelé la satisfaction exprimée à l'égard de leurs résultats par le CGPM à sa seizième session, en 1982.

M. le Professeur E. Vannini, Directeur de l'Institut de zoologie de l'Université de Bologne - dont dépend le laboratoire de Fano - a transmis à l'assemblée les vœux formulés par le Recteur de l'université pour le succès de la réunion, appelée à jouer un rôle essentiel si l'on considère l'intérêt économique et social des pêches en mer Adriatique.

M. A. Amati, Président du Consortium du laboratoire de biologie marine et des pêches de Fano, a souhaité la bienvenue à la réunion dont - a-t-il ajouté - les professionnels de la pêche attendent des résultats concrets. Une bonne connaissance des ressources est en fait une condition préalable à leur exploitation rationnelle par les Etats intéressés, ainsi que la base de bonnes relations entre pays.

Au nom de la délégation yougoslave, M. S. Jukić a remercié ses collègues italiens et le CGPM d'avoir organisé la consultation. Il a fait observer qu'elle coïncidait avec le dixième anniversaire de la collaboration italo-yougoslave pour l'étude des ressources de l'Adriatique et a exprimé le vœu que cette collaboration continue de se développer à l'avenir.

3. L'ordre du jour reproduit à l'annexe A a été approuvé.

4. Messieurs C. Piccinetti et S. Jukić ont été élus respectivement Président et Vice-Président de la Consultation.

5. La liste des participants figure à l'annexe B.

II. PROGRES ACCOMPLIS DANS LA CONSTITUTION D'UNE BASE DE DONNEES BIOLOGIQUES

A. Eléments descriptifs du milieu (voir annexes D, E, F, G) ^{1/}

6. La préparation d'un atlas hydrographique de l'Adriatique se poursuit et l'on pense que l'Istituto di Ricerche di Pesca Marittima (IRPEM) d'Ancône aura déjà des résultats substantiels à présenter sur cette question au moment où se tiendra la quatrième consultation technique.

7. Le débat a tout d'abord porté sur les problèmes qu'entraînent les longs délais avec lesquels les données océanographiques sont publiées dans la région; la Consultation a recommandé que ces renseignements soient communiqués rapidement aux instituts intéressés de la région et qu'ils soient, dans la mesure du possible, réunis et reproduits sous une forme normalisée.

8. Les données relatives à l'environnement peuvent avoir un intérêt pour la science halieutique à trois égards principalement:

- i) En tant qu'indices et instruments de prévision des fluctuations à court terme des conditions de la pêche et de la répartition des stocks de poisson (d'où la nécessité de communiquer rapidement les renseignements);
- ii) En tant qu'indices des conditions moyennes de l'environnement (mais on a souligné qu'il faut également connaître les valeurs extrêmes des variables importantes, car celles-ci influent davantage sur la situation zoogéographique);
- iii) Les séries chronologiques à long terme de statistiques importantes portant sur des caractéristiques physiques et biologiques sont particulièrement utiles en tant qu'indices de variations ou de périodicités à long terme susceptibles d'avoir un effet sur le recrutement et sur la biomasse. L'expérience acquise en d'autres lieux a montré que si une pêche intensive a des effets déterminants et contrôlables sur les stocks, il peut être plus facile dans ce cas de mettre en évidence des fluctuations du recrutement correspondant à des signaux écologiques que si l'exploitation est légère.

^{1/} La liste des documents présentés à la Consultation figure à l'annexe C.

9. On a évoqué la nécessité de normaliser la collecte des données océanographiques, pour résoudre les difficultés que pose l'harmonisation des renseignements recueillis au moyen de méthodes différentes, ce qui en rend l'exploitation difficile. Il a été recommandé de mettre au point une méthodologie et un protocole normalisés pour la collecte des données hydrographiques, qui seraient tous deux utilisés pour les campagnes hydrographiques et halieutiques. Il a été demandé à M. Artegiani de préparer un projet de protocole pour la mesure d'un nombre restreint de paramètres importants et, après consultation avec les instituts membres et en tenant compte des pratiques scientifiques en usage dans d'autres zones, de communiquer ce protocole à d'autres instituts afin qu'ils s'en servent dans de futures campagnes océanographiques.

10. La nécessité d'une banque centralisée de données pour réunir les données hydrographiques a été évoquée et l'IRPEM s'est offert à remplir cette fonction, dont il sera question au paragraphe 88.

11. L'expérience acquise grâce au programme coopératif italo-yougoslave ASCOP (Programme de coopération scientifique dans l'Adriatique) a été citée comme un exemple des types de normalisation possibles.

12. De toute manière, on a discuté de la possibilité que ces renseignements, enregistrés sur rubans magnétiques, soient rassemblés quelque part aux fins de compilation. Ces renseignements pourraient ensuite être communiqués sur demande par le centre désigné aux instituts intéressés.

13. D'autres types de données hydrographiques ont été examinés, notamment les débits des cours d'eau qui se jettent dans l'Adriatique et en particulier celui du Pô (voir annexe H), ce paramètre jouant un rôle déterminant dans la circulation générale et les gradients de salinité dans la mer en question. Il conviendrait d'établir des séries chronologiques longues des données disponibles concernant les débits ainsi que d'autres séries chronologiques longues de données hydrographiques et de quelques données météorologiques; le tout serait présenté à la prochaine consultation et servirait de point de départ à l'étude des incidences éventuelles de l'hydrographie sur les stocks ichthyiques. Un exemple des effets possibles de l'environnement sur la dimension des stocks concerne la population d'anchois, encore que d'aucuns aient exprimé l'opinion que, pour la plupart des autres espèces, l'effort de pêche joue un rôle déterminant sur la dimension du stock.

14. La Loi italienne 979 du 31 décembre 1982 envisage la création d'un centre national de données et de suivi des renseignements (données chimiques et physiques) concernant l'environnement marin. Le centre bénéficiera du concours de l'Istituto Centrale per la Ricerca Scientifica et Tecnologica applicata alla Pesca Marittima.

B. Cartes des peuplements ichthyiques

15. Des renseignements détaillés concernant la répartition des diverses espèces ont été présentés dans la documentation (voir annexes I, J, K); les travaux relatifs à l'établissement d'un atlas plus complet des stocks de poissons de l'Adriatique devraient se poursuivre sur une base coopérative et faire l'objet d'un rapport à la prochaine consultation.

C. Résumé des paramètres biologiques

16. Les documents présentés à la Consultation (voir annexes L à Y) contenaient un grand nombre de nouvelles estimations des paramètres démographiques. Ces données, classées par espèces et par auteurs, sont reproduites dans les tableaux 1 et 2. Elles confirment la conclusion formulée un peu plus loin dans le rapport (prospections par chalutages) concernant le niveau relativement élevé de la mortalité et les bas âges moyens au moment de la première capture (âge 1 environ), ainsi que les âges relativement jeunes au moment de la première reproduction (âges 1 - 2). Ces résultats semblent indiquer l'effet éventuel d'une faible survie sur la maturité ainsi que sur le recrutement, et méritent sérieusement des études ultérieures.

17. D'une manière générale, il semble que nombre des espèces exploitées aient un L_{∞} bas et pénètrent dans la pêcherie pour la première fois alors qu'ils appartiennent aux groupes d'âge 0 ou 1, la maturité sexuelle intervenant à l'âge 1-2. Les estimations du taux d'exploitation sont fortement tributaires d'estimations indirectes de la mortalité naturelle (Tanaka, Pauly et Taylor) ^{1/} mais le niveau d'exploitation semble en général assez intense.

1/ Tanaka, S., 1960, Studies on the dynamics and the management of fish populations. Bull. Tokai Reg. Fish. Res. Lab. (28): 1-200

Pauly, D., 1982, Une sélection de méthodes simples pour l'estimation des stocks de poissons tropicaux. FAO Circ. Pêches, (729): 63 p.

Taylor, G.C., 1959, Temperature and growth. The Pacific razor clam. J. Cons. int. Explor. Mer., 25 (1): 93-101.

Tableau 1: Relations taille (cm) - poids (g), facteurs de condition et fécondité

ESPECES	a	b	n	Auteurs
<u>Squilla mantis</u> L.	M 0,0116 F 0,0138	3,0431 2,9168	71 128	Giovanardi et Piccinetti Manfrin
fécondité = 50.000 oeufs/femelle				
<u>Loligo vulgaris</u> Lam.	0,04703	2,788	94	Flamini et Giovanardi
<u>Sepia officinalis</u> L.	0,22041	2,773	30	Piccinetti Manfrin et Giovanardi
<u>Merlangius merlangus</u> (L.)	0,00607	3,109	202	Giovanardi et Rizzoli
<u>Trisopterus minutus capelanus</u> (Risso)	0,00498	3,269	563	Tangerini et Arneri
<u>Sardina pilchardus</u> (Walb.) fécondité = 606,6 W fécondité = 606,6 W 1,124	0,00561	3,033	/	Sinoveic
<u>Trachurus trachurus</u> (L.)	1,21 X 10 ⁻⁵	2,9176	1,726	Alegria V.
<u>Trachurus mediterraneus</u> (Steind.)	0,00555	3,105	560	Arneri et Tangerini
<u>Gobius niger</u> L.	M 0,00882 F 0,02211	3,12 2,73	1,474 875	Fabi et Frogia
<u>Arnoglossus laterna</u> (Walb.)	M 6,83 X 10 ⁻³ F 2,08 X 10 ⁻³	3,03 3,28	38 29	Giovanardi et Piccinetti
<u>Solea vulgaris</u> Quensel	M 0,00571 F 0,00864	3,143 3,013	74 85	Piccinetti et Giovanardi
fécondité = 300 - 400 g/ femelle = 150,000 - 200,000 oeufs/femelle				

Tableau 2: Taux de croissance et de mortalité

ESPECES (sexe)	K	L _∞ (cm)	t ₀	W	l ₅₀	Z	M	F	lm ₅₀ ou tn 50	Auteurs
<u>Squilla mantis</u> L.									≤ 2 ans 1 an 10+cm	Giovanardi et M. Piccinetti
<u>Sepia officinalis</u> L.										
<u>Sardina pilchardus</u> Walb.	0,46	20,5	- 0,5	86,15 g		0,74	0,5 ^a	0,24	14 cm	Sinovic
<u>Sardina pilchardus</u> Walb.	min. max. 0,29/0,37	min. max. 18,8 / 19,1	min. max. - 3,0/-	min. max. 50,744 54,693		min. max. 0,53 0,73	min. max. 0,32 0,52	0,21		Levi et al
<u>Merluccius merluccius</u> L.	0,12	85,0	/	/		0,92	0,25	0,75		Flamigni
<u>Merlangius merlangus</u> L.						1,05			≤ 1 an 20 cm	Giovanardi et Rizzoli
<u>Trisopterus minutus capellanus</u> (Risso)									≥ 1 an 13 cm	Tangerini et Arneri
<u>Trachurus trachurus</u> L.	0,22	37,55	1,28						15-18 cm	Alegria
<u>Trachurus mediterraneus</u> (Stein.)									≤ 2 ans ≥ 16,8 cm	Arneri et Tangerini
<u>Gobius niger</u> L.									7,5/8,5 cm	Pabi et Frogolia
<u>Arnoglossus laterna</u> Walb.	0,572	15,812			10/11 cm	1,40 - 1,60	0,57 x		→ 1 an 6,8 cm	Giovanardi et Piccinetti
<u>Solea vulgaris</u> Quensel	0,68	40,10			15 cm	1,4-2,0	0,9 x 0,6 •			Piccinetti et Giovanardi

Δ Méthode de Taylor (1959)
 • Méthode de Tanaka (1960)
 x Estimation d'après la méthode de Pauly (1980)

18. On s'est demandé si les échantillons de fréquences de taille provenant des campagnes océanographiques étaient représentatifs ou non de la population. Un échantillonnage systématique, utilisant par exemple les transects, peut fournir de bonnes informations sur la répartition et les mouvements saisonniers des stocks mais ces renseignements une fois regroupés seront toujours quelque peu suspects du point de vue de la représentativité de la population dans son ensemble si, pour choisir les différents échantillons à rassembler, on ne suit pas un programme d'échantillonnage aléatoire stratifié.

19. On a insisté sur la nécessité de présenter, dans les documents d'évaluation, les données d'origine sur les captures et l'effort avec si possible un graphique de la relation à représenter, méthode qui permet à d'autres chercheurs de poursuivre les analyses et de faire des comparaisons.

20. Concernant l'analyse des fréquences de taille, il a été souligné que l'on se trouve en face de deux besoins contradictoires selon l'objectif visé. Pour l'analyse modale, il faut des échantillons relativement vastes, maintenus séparés et recueillis à intervalles réguliers sans regroupement des données.

21. Pour l'analyse des taux de mortalité (par exemple par des courbes des captures ou d'après des estimations de la taille moyenne, etc.), il faut avoir des compositions par taille dites stationnaires" correspondant d'aussi près que possible à une condition d'équilibre par rapport au taux prédominant de mortalité par pêche. Pour obtenir une approximation de ce type de distribution, il faudra regrouper les données correspondant à plusieurs années successives. Dans un travail de ce genre, il faudra donc distinguer entre ces deux critères.

22. On a souligné également qu'il importe, dans les deux cas, de différencier les données selon le sexe pour les espèces dont la croissance et la mortalité naturelle diffèrent.

23. Concernant les espèces sédentaires (par exemple les mollusques), on a examiné la possibilité de fermer des zones restreintes à la pêche, afin de pouvoir déterminer directement le taux de mortalité naturelle. Malgré des difficultés pratiques évidentes, l'idée mérite probablement d'être approfondie, notamment dans le cas des pêcheries de "vongole" (*Venus gallina*).

24. La proportion de poissons cartilagineux dans la capture est un indice du taux local d'exploitation car, en général, il s'agit d'espèces vivant longtemps, donc vulnérables à des taux élevés de pêche.

III. PROGRES ACCOMPLIS DANS LE DOMAINE DES STATISTIQUES

A. Albanie

25. Le Département des pêches rassemble des données sur la pêche au chalut et la pêche pélagique. Les renseignements disponibles sur la pêche côtière ne sont pas très fournis. Pour la petite pêche pélagique au chalut et la pêche côtière, les données sont établies séparément. Les espèces particulièrement importantes sur le plan économique sont la sardine, le merlu, le bogue et le chinchard. Les captures de mullets prédominent dans la pêche côtière.

B. Italie

26. Les données provenant des enquêtes cadres sur la situation actuelle des flottilles de pêche primaires effectuées dans le cadre du programme PESTAT ont été enregistrées sur ruban magnétique et ont été confiées à l'ISTAT et à l'EUROSTAT: elles font maintenant partie de la base de données officielles italiennes sur les statistiques des pêches (voir annexe Z). Une série de recueils portant sur les méthodes et les données statistiques sera publiée sous peu.

27. Des données concernant les captures et l'effort ont été recueillies pendant deux ans sur une série d'emplacements échantillonnés sur la base des probabilités. Cette étude, exécutée en coopération avec la FAO, est un contrôle de la qualité des données statistiques officielles italiennes sur les pêches. La vérification des données relatives aux captures et à l'effort, leur transcription sur ruban magnétique et leur analyse constitueront les priorités suivantes. Des problèmes d'effectifs et de crédits imposent évidemment certaines limites à ce qui peut être fait dans l'immédiat.

28. Dans le cadre de la Loi No. 41 (passée en février 1982), il sera désormais possible d'améliorer la collecte des données et le recrutement des techniciens nationaux; la responsabilité de la collecte des statistiques halieutiques incombe actuellement au Ministère de la marine marchande. La loi No. 41 stipule qu'un groupe de travail sera créé auprès de l'Istituto Centrale di Statistica pour étudier la faisabilité d'un nouveau système statistique halieutique national opérant en permanence. La Consultation a recommandé à ce groupe de travail de reconnaître l'importance d'une méthode correcte et scientifiquement valable de collecte des statistiques halieutiques pour une bonne évaluation des stocks. Elle l'a donc instamment invité à concourir à la mise en place rapide d'un tel système d'échantillonnage.

29. D'une manière générale, on a insisté sur la nécessité de communiquer à la FAO les statistiques nationales pour qu'elles soient incluses dans celles qui paraissent dans le Bulletin statistique du CGPM et sont mises à jour tous les deux ans, et exhorté chaque pays à soutenir cette fonction vitale pour l'évaluation sous-régionale des stocks en lui attribuant des ressources appropriées.

30. La Consultation a de nouveau souligné à cet égard l'importance de l'initiative du PESTAT, dont on espère qu'elle se transformera en un système permanent de collecte régulière, dans un certain nombre de ports, de statistiques italiennes sur les captures et l'effort de pêche portant sur les espèces spécialement intéressantes de l'Adriatique.

C. Yougoslavie

31. La délégation yougoslave a déclaré que, même s'il n'existe pas encore de statistiques irréfutables de la production halieutique italienne dans l'Adriatique, on peut estimer *grosso modo* que cette production est environ dix fois celle de la Yougoslavie, et que la flottille italienne est de dix à quinze fois plus importante que la flottille yougoslave. La Consultation devra affronter la question de la stratégie globale et des priorités d'aménagement des stocks de l'Adriatique, car l'aménagement rationnel de l'industrie de la pêche en dépend au plus haut point.

32. Compte tenu des disparités locales et nationales des modes d'exploitation des stocks de l'Adriatique, la délégation yougoslave a souligné qu'il est des plus important d'obtenir des flottilles nationales qu'elles fournissent de bonnes statistiques en raison du degré excessif d'exploitation que les spécialistes yougoslaves de l'évaluation des stocks observent actuellement.

33. La constitution de la base de données concernant la pêche au chalut s'est ressentie de divers problèmes, liés au renouvellement du programme interne du Département statistique de Zagreb et au départ du fonctionnaire qui s'occupait du rassemblement des données.

D. Effort de pêche

34. Les données relatives à l'effort de pêche pour la sardine et l'anchois sur la côte yougoslave de l'Adriatique sont fournies sous la forme du nombre de jours ou de nuits de pêche. Certaines coopératives enregistrent également des données sur l'effort de chalutage. L'activité du secteur privé (chalutage et pêche pélagique) n'est pas prise en compte dans le système actuel.

35. Concernant l'Italie, deux pêcheries travaillent avec des permis de pêche, celle qui exploite Venus gallina (vongole) et la pêche au chalut sur le littoral nord-adriatique. Une des conditions de l'octroi des permis de pêche est que le titulaire doit présenter chaque mois un rapport sur le nombre de jours passés en mer et sur ses captures. Pour la pêcherie de Venus gallina, il est possible d'effectuer certains contrôles en se servant des registres des organisations professionnelles et des mareyeurs.

36. L'Albanie, quant à elle, réunit des renseignements sur le nombre de navires opérant dans les secteurs de la pêche pélagique et du chalutage dans les eaux démersales.

IV. ETAT DES STOCKS DEMERSAUX

A. Modèle de production

37. Aucun progrès n'a été signalé à ce jour concernant l'application de ce type d'approche aux ressources démersales, en grande partie parce que la base de données est insuffisante.

B. Prospections par chalutage (voir annexe AA)

38. Les prospections mixtes italo-yougoslaves (entreprises en avril-mai et novembre-décembre 1982) au moyen du navire de pêche commerciale "Pipeta" ont été examinées, et notamment comparées avec la précédente expédition "Hvar" 1948-49, qui avait été la dernière expédition de ce type entreprise peu après la deuxième guerre mondiale, en un temps où les populations ichthyiques étaient restées inexploitées pendant quelques années. Les stations de cette campagne étaient disséminées le long de transects, avec une plus forte densité de stations dans le nord et le centre de l'Adriatique, où la pêche commerciale est très intense. Sur les 80 espèces recueillies, la moitié environ (voir tableau 3) présente une importance commerciale et la plus grande partie des captures (plus de 50 pour cent en nombre) se compose de sujets appartenant aux classes d'âges 0 et 1.

39. D'une manière générale, la Consultation a admis l'intérêt de poursuivre cet effort de collaboration, et la discussion a d'abord tourné autour de la définition d'une stratégie optimale de prospections.

40. On a reconnu que le grand nombre d'espèces, leurs fluctuations saisonnières et leur manque d'homogénéité spatiale rendent quelque peu difficile la planification des campagnes mais on a considéré généralement que les mois de novembre-décembre constituaient la meilleure période pour des prospections périodiques car à ce moment-là les juvéniles de l'année peuvent être recrutés par l'engin.

Tableau 3: Espèces de l'Adriatique présentant un intérêt commercial. Rendement général moyen - Novembre 1982 1/.

Table 3: Adriatic species of commercial importance. Average general yields - November 1982 1/.

	kg/h	%
<i>Eledone moschata</i> (Lam.)	5.17	16.7
<i>Mullus barbatus</i> (L.)	3.52	11.4
<i>Trisopterus minutus capellanus</i> (Lac.)	3.35	10.9
<i>Trachurus mediterraneus</i> (Steind.)	2.02	6.6
<i>Merluccius merluccius</i> (L.)	1.55	5.0
<i>Sepia officinalis</i> (L.)	0.99	3.2
<i>Gobius niger</i> (L.)	0.94	3.0
<i>Trachurus trachurus</i> (L.)	0.88	2.8
<i>Squilla mantis</i> (L.)	0.83	2.7
<i>Merlangius merlangus</i> (L.)	0.68	2.2
<i>Pagellus erythrinus</i> (L.)	0.55	1.8
<i>Squalus acanthias</i> (L.)	0.54	1.7
<i>Lophius piscatorius</i> (L.)	0.44	1.4
<i>Loligo vulgaris</i> (Lam.)	0.41	1.3
<i>Scylliorhinus canicula</i> (L.)	0.34	1.1
<i>Raja clavata</i> (L.)	0.30	1.0
<i>Nephrops norvegicus</i> (L.)	0.28	0.9
<i>Microchirus variegatus</i> (Donovan)	0.28	0.9
<i>Conger conger</i> (L.)	0.25	0.8
<i>Mustelus asterias</i> (Cloquet)	0.22	0.7
<i>Sepia elegans</i> (d'Orbigny)	0.20	0.6
<i>Lophius budegassa</i> (Spinola)	0.15	0.5
<i>Alloteuthis media</i> (L.)	0.14	0.4
<i>Trachinus draco</i> (L.)	0.11	0.4
<i>Zeus faber</i> (L.)	0.10	0.3
<i>Trigla lyra</i> (L.)	0.09	0.3
<i>Trigla lucerna</i> (L.)	0.10	0.3
<i>Eutrigla gurnardus</i> (L.)	0.10	0.3
<i>Arnoglossus laterna</i> (Walbaum)	0.08	0.3
<i>Scorpaena scrofa</i> (L.)	0.08	0.2
<i>Lepidorhombus</i> sp.	0.07	0.2
<i>Solea vulgaris</i> (Quensel)	0.08	0.2
<i>Buglossidium luteum</i> (Risso)	0.05	0.2
<i>Penaeus kerathurus</i> (Forsk.)	0.02	0.1
<i>Uranoscopus scaber</i> (L.)	0.05	0.1
<i>Citharus macrolepidotus</i> (Bloch)	0.03	0.1
Total	24.99	80.6
Autres espèces	5.87	19.4

1/ D'après une communication de C. Piccinetti et S. Jukić / From C. Piccinetti and S. Jukić.
 Considérations sur les premiers résultats de la campagne de chalutage "Pipeta".
 (voir annexe AA / See Appendix AA).

41. Il est prévu de poursuivre les campagnes mixtes car, vu les lacunes de certaines statistiques commerciales, celles-ci constituent la méthode la plus directe pour surveiller en permanence la ressource. Ces campagnes, ainsi que l'approche systématique actuellement utilisée pour choisir les stations (c'est-à-dire par transects) fourniront des indices de l'abondance (et de ses fluctuations) d'espèces importantes et nous disposons d'ores et déjà d'une meilleure base de données concernant la répartition des espèces, comparée à ce qui existait auparavant. Pour obtenir des estimations de la biomasse assorties de limites de confiance, il faudrait cependant envisager de mettre au point un plan stratifié de prospections; un groupe restreint s'est réuni pour examiner les possibilités de dégager un schéma général de strates applicables aux prospections par chalutages démersaux dans l'Adriatique (voir appendice 1).

42. En comparant les résultats de la prospection "Pipeta" avec ceux de l'expédition "Hvar", on a constaté que le taux de capture avait sensiblement baissé dans l'intervalle, malgré des améliorations des engins de chalutage et de l'efficacité de la pêche depuis 1949. Cet examen comparé fera l'objet d'un rapport qui sera soumis à la prochaine consultation. Entre-temps, les données "Pipeta" seront analysées et communiquées aux instituts des pêches de la région. On ne possède plus les données relatives aux fréquences de tailles de la croisière précédente et cela est dommage car elles auraient fourni des estimations directes de M pour les principales espèces.

43. Le fait que, dans la récente prospection, la moyenne d'âge se situe au-dessous ou au voisinage d'un an est inquiétant car l'on sait que plusieurs espèces importantes peuvent atteindre 4 à 5 ans, sinon plus, en régime de faible exploitation. Si l'on prend un âge de première capture d'environ 0,3-0,5 an, les âges moyens actuels correspondent à des valeurs de:

$$Z = 1/(\bar{t} - t_c) = (1 - 0,3)^{-1} - (1 - 0,5)^{-1}$$

c'est-à-dire se situant autour de $Z = 1,4 - 2,0$. Si l'on suppose que la mortalité naturelle se situe, pour la plupart des espèces, dans la fourchette $M = 0,3 - 0,8$, on peut en déduire que le taux de mortalité par pêche est élevé, probablement même supérieur à $F = 1,0$. Evidemment, il faudrait affiner ultérieurement cette méthode d'analyse des données obtenues par chalutages. Par exemple, il est possible d'obtenir une fréquence générale de tailles pour chacune des espèces contenues dans la capture effectuée à des fins scientifiques, et d'utiliser cette donnée pour obtenir des estimations de la mortalité par âge (analyse des fréquences de tailles, Jones. Circulaire FAO sur les pêches No. 734) et de la longueur moyenne (donc de l'âge moyen, si l'on dispose de paramètres de croissance), au moyen de l'équation:

$$\bar{t} = -1/K \ln \left(\frac{L_{\infty} - \bar{l}}{L_{\infty}} \right) + t_0$$

ainsi que des estimations approximatives de L_{∞} et, partant, de t_0 en utilisant la méthode employée au cours de la deuxième Consultation technique sur l'évaluation des stocks dans les divisions Statistiques Baléares et golfe du Lion). (Rapport FAO sur les pêches No. 263). Le seul problème qui se pose ici c'est qu'il faudrait être sûr que la fréquence générale des tailles est représentative de la population. Cela est difficile à dire en l'absence d'un plan de chalutage stratifié, mais la Consultation a recommandé que l'on établisse ces fréquences générales de taille et que l'on effectue les calculs nécessaires pour obtenir des estimations provisoires de t , et par conséquent de Z .

44. L'analyse préliminaire des résultats de cette campagne indique que le type de sédiment joue un rôle important dans la distribution du benthos mais aussi de nombreuses espèces associées de poissons et d'invertébrés présentant un intérêt commercial (Voir annexe BB). Les sables reliques et les sables argileux reliques rassemblent les plus fortes densités de poissons. A l'évidence, la connaissance du type de sédiment et/ou de la répartition de la biocénose devra occuper une place importante dans la préparation des futures **prospections** par chalutage.

C. Autres méthodes

45. Le Secrétaire technique a présenté (voir figure 1) les résultats d'une analyse préliminaire des rendements par recrue effectuée en utilisant les tables des rendements de Beverton et Holt (1966) pour *Merluccius merluccius* (L.) et des estimations des paramètres fournies par Jukić et Piccinetti (voir annexe L au rapport de la deuxième Consultation sur l'Adriatique). D'après d'autres expériences, la valeur de M pour cette espèce se situe probablement dans la gamme $M = 0,2 - 0,4$ et, après examen des données relatives à la fréquence des tailles, I_C (taille où 50 pour cent des poissons sont retenus) se situe autour de 14 - 16 cm. On a utilisé ces valeurs pour compléter ceux des tableaux de Beverton et Holt (1966) qui correspondaient de plus près à $M/K = 0,2/0,12 = 1,67$ et $M/K = 0,4/0,12 = 3,33$: c'est-à-dire les Tableaux qui donnent $M/K = 1,5$ et $M/K = 3,00$.

a)

$M/K = 3.00$

c E .05 .10 .15 .20 .25 .30 .35 .40 .45 .50 .55 .60 .65 .70 .75 .80 .85 .90 .95 1.0

66
64
62
60

58
56
54
52
50

48
46
44
42
40

38
36
34
32
30

28
26
24
22
20

18
16
14
12
10

00

F/M .0526 .111 .177 .250 .333 .429 .539 .667 .818 1.00 1.22 1.50 1.86 2.33 3.00 4.00 5.67 9.00 19.0
F/K 15 .33 .53 .75 1.0 1.3 1.6 2.0 2.5 3.0 3.7 4.5 5.6 7.0 9.0 12 17 27 57

b)

$M/K = 1.5$

c E .05 .10 .15 .20 .25 .30 .35 .40 .45 .50 .55 .60 .65 .70 .75 .80 .85 .90 .95 1.0

52
50

48
46
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20

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12
10

00

F/M .0526 .111 .177 .250 .333 .429 .539 .667 .818 1.00 1.22 1.50 1.86 2.33 3.00 4.00 5.67 9.00 19.00
F/K 0.79 .17 .26 .38 .50 .64 .81 1.0 1.2 1.5 1.8 2.3 2.8 3.5 4.5 6.0 8.5 14 29

Figure 1: Rendements par recrue de Merluccius merluccius de l'Adriatique avec deux hypothèses différentes:

a) $M \approx 0,2$; b) $M \approx 0,4$

Les flèches vont de la meilleure approximation possible de l'état actuel (P) de la pêcherie au taux d'exploitation (flèche horizontale) et à la taille à première capture (flèche verticale) donnant le rendement par recrue maximum, les autres variables demeurant constantes.

Dans une analyse plus détaillée du rendement par recrue faite au moyen de programmes d'ordinateur disponibles à cette fin, il faudrait utiliser la véritable valeur de M/K , mais ces tableaux fournissent un moyen rapide et utile d'intégrer les analyses des rendements par recrue pour une pêcherie plurispécifique, en particulier quand les valeurs des paramètres ne sont connues que de façon approximative (voir annexe M au rapport de la deuxième Consultation sur la Méditerranée occidentale). Après manipulation des paramètres de façon à obtenir $C = 1_C / 1_{00}$ comme indice de la taille de première capture, et $E = F/Z$ (sommet du tableau de Beverton et Holt, 1966) ou F/M (bas du tableau) comme indices de la mortalité due à la pêche, on peut lire les valeurs de Y' . La quantité Y' est proportionnelle au rendement par recrue et peut être comparée directement pour obtenir le pourcentage de variation de Y/R correspondant à toute modification de C et de F/M . Dans l'exemple donné (tableau de Beverton et Holt, 1966 et figure 1), l'importance d'une bonne estimation de M est évidente car, même si dans les deux cas l'avantage d'un accroissement de taille à la première capture apparaît clairement, Y/R n'augmentera que de 30 pour cent au maximum si $M = 0,4$, tandis que l'augmentation pourra atteindre 180 pour cent si $M = 0,2$ en supposant dans les deux cas que F ne varie pas.

L'analyse des effets d'un changement de F avec la taille actuelle de première capture de Merluccius pour $M = 0,4$ indique que la mortalité par pêche actuelle est optimale. Cependant, un accroissement du rendement par recrue de 70 pour cent est possible en théorie si l'on adopte la taille de première capture donnant le meilleur Y/R pour la mortalité par pêche actuelle. Cette nouvelle taille actuelle de la première capture serait approximativement le double de la taille actuelle (34 cm environ au lieu de 15 cm).

46. Au cours du débat consacré à ces résultats préliminaires, on a vivement insisté sur le danger qu'il y aurait à sauter immédiatement aux conclusions en ce qui concerne l'aménagement de la pêcherie tant que trois conditions préalables n'auront pas d'abord été satisfaites, à savoir:

- a) Effectuer des estimations des paramètres et des calculs de Y/R pour un plus grand nombre des trente espèces importantes de cette pêcherie plurispécifique;
- b) Définir les incidences économiques susceptibles de résulter, tant à court terme qu'à long terme, d'une éventuelle modification des réglementations;
- c) Réunir de meilleurs renseignements concernant les quantités actuellement prélevées sur cette ressource et débarquées, afin de pouvoir surveiller toute modification que pourraient éventuellement entraîner des variations des valeurs de C et de F sur la pêcherie.

A propos de l'analyse des données saisonnières relatives aux fréquences de longueurs, d'après des fréquences régulières (par exemple mensuelles) des tailles de capture, le Secrétaire technique a parlé de la mise au point de nouvelles méthodes qui devraient être disponibles au moment de la prochaine consultation; elles s'appliquent tout spécialement aux espèces à cycle biologique court et aux pêcheries saisonnières.

D. Recommandations relatives à l'état des stocks démersaux et recherche intersessions

47. Prospections par chalutages

- a) L'analyse des données provenant des récentes campagnes scientifiques en commun devrait si possible viser à compléter l'atlas de la répartition des espèces;
- b) Les chercheurs devraient également s'efforcer d'obtenir des indices des taux de mortalité d'après la répartition générale des fréquences de tailles pour la zone prospectée.
- c) Pour cela, il faudra des renseignements sur le taux de croissance des espèces importantes, et ajuster les courbes de croissance de von Bertalanffy.
- d) Il serait utile également d'examiner le mode de distribution des différents groupes d'âges, pour établir ou vérifier les systèmes migratoires en fonction de l'âge.
- e) Il serait bon de comparer les modes de distribution, les taux de capture et les espèces capturées dans les mêmes zones et stations que celles de la prospection du "Hvar".
- f) Il conviendrait que toutes les nations situées en bordure de l'Adriatique continuent d'explorer la possibilité de mettre au point un programme commun de stratification pour les chalutages de fond, suivant les suggestions formulées par le Groupe de travail ad hoc (voir appendice 1).

Tableau 4: Exemple de calcul des pourcentages de variations du rendement par recrue de Merluccius merluccius d'après les tableaux de Beverton - Holt (1966) si F se déplace vers des valeurs correspondant au rapport Y/R maximum pour les valeurs actuelles de C, et les tailles de première capture se déplacent vers des valeurs fournissant le rapport Y/R maximum pour les valeurs actuelles de F.

Paramètres utilisés: $K = 0,12$ $1c = 14 - 16$ cm c'est-à-dire $C = \frac{1c}{L} = 0,165 - 0,188$
 $Z = 0,79$ $L = 85$ cm

M =	0,2 (Z - M = F = 0,59; F/M ~ 3,00)	0,4 (Z - M = F = 0,39; F/M ~ 1,00)
a) modification de la taille de première capture:		
Valeur actuelle de C = 0,18	de C = 0,16 - 0,18 à C = 0,60	de C = 0,16 - 0,18 à C = 0,38
C = 0,16	de Y' = 0,020466 à Y' = 0,54789	de Y' = 0,010273 à Y' = 0,013314
Variation prévisible de Y/R	de Y' = 0,018745 + 179,4 pour cent	de Y' = 0,009845 + 32,4 pour cent
b) modification du taux de mortalité par pêche		
	de F/M = 3,00 à F/M = 0,818	de F/M = 1,00 à F/M = 0,818
Valeur actuelle de C = 0,18	de Y' = 0,020466 à Y' = 0,033820	la valeur F actuelle est optimale pour la valeur C donnée
C = 0,16	de Y' = 0,018745 à Y' = 0,32945	
Variation prévisible de Y/R	+ 70,2 pour cent	0 pour cent

Analyse des rendements

48. Il faudrait tenir compte de l'idée de suivre les analyses du rendement par recrue en ce qui concerne les espèces pour lesquelles on dispose de données. Cette étude permettrait de trouver des méthodes plus souples pour évaluer les incidences des stratégies halieutiques sur les stocks, comme par exemple la formule de Ricker concernant le rendement par recrue, qui est la mieux adaptée aux pêcheries saisonnières portant sur des espèces à cycle biologique court. Ce type de méthodologie peut également s'appliquer à l'échantillonnage mensuel des fréquences de tailles par exemple.

V. ETAT DES STOCKS PELAGIQUES

A. Progrès accomplis dans le domaine des statistiques

49. Des renseignements concernant la collecte des statistiques halieutiques ont été donnés dans la section III, dont les conclusions s'appliquent également à la pêche pélagique: essentiellement, tous les Etats situés en bordure de l'Adriatique ont des difficultés à réunir des statistiques halieutiques d'un niveau satisfaisant - qu'il s'agisse de mettre en place des systèmes scientifiques de collecte des données ou de trouver les ressources nécessaires pour faire fonctionner ces systèmes au niveau voulu de complétude et d'exactitude. Concernant l'effort de pêche, les Yougoslaves continuent de réunir des renseignements pour les bateaux de pêche pélagique travaillant pour des coopératives, mais non pour les navires appartenant à des particuliers. L'Italie a mis en route, à titre d'essai, un système de collecte de données statistiques pour les espèces pélagiques de l'Adriatique qui porte sur l'effort de pêche - données normalisées, dans ce cas, en les ramenant à un type d'engin pélagique déterminé, le "volante", que l'on trouve dans tous les ports de pêche italiens situés le long de l'Adriatique et qui a servi de base pour la normalisation.

50. Ce programme a été interrompu en décembre 1981, d'une part parce que le responsable de la recherche est parti et d'autre part qu'il a fallu se concentrer sur le traitement des données. Pendant les trois mois qui ont précédé la Consultation, l'équipe de recherche s'est employée à acquérir les connaissances nécessaires pour poursuivre le programme, tant dans le cadre de stages de formation organisés à Mazara del Vallo que par le traitement des données lui-même. Le programme devrait donc reprendre très rapidement.

51. A ce sujet, une analyse préliminaire de ces données a montré que la puissance (à l'arbre) du navire constitue la meilleure mesure de la puissance de pêche relative en ce qui concerne le type de bateau à "volante" choisi comme norme, si l'on en juge d'après une étude conduite dans le port de Cesenatico. L'effort de normalisation est rendu compliqué par l'extrême diversité des navires de pêche locaux, ainsi que par les variations saisonnières (séquentielles) et spatiales de la distribution et des migrations des stocks pélagiques le long de la côte.

B. Modèles de production

52. La Consultation a examiné une étude traitant de l'application des modèles de production à la population de sardines (*Sardina pilchardus* Walb.) de Yougoslavie (voir annexe CC). Les estimations du RME (autour de 25 000 tonnes) et de fopt, (3 600 - 4 800 journées de pêche) (modèles exponentiel et linéaire respectivement) sont sans changement par rapport à un ajustement précédent 1/, ce qui laisse à penser que, ces dernières années, l'effort a été quelque peu supérieur à fopt, même si certains indices montrent que l'intensité de la pêche a diminué au début des années 80. Le débat a tourné autour de l'efficacité-coût de ce type d'approche pour la surveillance des pêcheries, comparée aux prospections acoustiques et aux études des oeufs et des larves.

53. Une seconde étude (voir annexe DD) basée sur un modèle de production pour la pêche de l'Adriatique ouest a abouti à une estimation du RME de 21 000 tonnes.

54. Nous verrons un peu plus loin dans la présente section les observations que suscitent, en relation avec le tableau 5, ces faibles estimations, si on les compare aux prospections acoustiques et aux études sur les oeufs. La question de l'application des résultats de ce type d'étude à l'aménagement est abordée dans la section G, mais de façon simplifiée. Le fait qu'on ne dispose pas actuellement de données d'ensemble sur les captures et sur l'effort pour une importante proportion de cette pêche qui exploite une ressource supposée commune rend l'application de ce type de modèle à une partie seulement du stock difficile à interpréter.

55. On a fait observer qu'il serait possible de pallier l'absence de données concernant l'effort pour une partie de la pêche si l'on disposait de données complètes sur les quantités débarquées et si les données yougoslaves concernant les taux de captures pouvaient être considérées comme représentatives de l'abondance du stock dans son ensemble.

1/ Alegria Hernández, V., 1981. Assessment of pelagic fish abundance along the eastern Adriatic coast with special regard to sardine (*Sardina pilchardus* Walb.) population. Ph. D. Thesis, Zagreb, 154 p.

C. Estimations de l'abondance et du taux d'exploitation des stocks

56. Pour estimer l'abondance et la biomasse des stocks pélagiques, toutes sortes de méthodes ont été utilisées, dont les résultats sont repris dans le tableau 5 qui récapitule les estimations fournies par plusieurs auteurs.

57. Les estimations de biomasse de sardine obtenues au moyen d'un modèle de production pour l'Adriatique est (113 - 236.10³t) ou par analyse des cohortes pour l'Adriatique nord et centre (46 - 162.10³t) sont du même ordre de grandeur que celles obtenues par les méthodes acoustiques pour l'ensemble de l'Adriatique (250.10³t), mais restent bien inférieures aux estimations moyennes tirées des études sur les oeufs (491-1 309.10³t).

58. Pour ce qui est de la biomasse de l'anchois, les données sont assez rares mais les estimations préliminaires obtenues par la méthode acoustique semblent indiquer un volume de stock de l'ordre de 300 à 2 000.10³t (moyenne 1 830.10³t) de 1976 à 1980 (tableau 5).

59. La Consultation a noté avec intérêt que les tendances de la biomasse de la sardine sont descendantes dans l'Adriatique ouest et ascendantes dans l'Adriatique est.

D. Relations entre les stocks pélagiques et certains paramètres du milieu

60. La production d'oeufs des stocks de poissons pélagiques tend à atteindre des niveaux élevés dans les périodes qui suivent des pointes de salinité en Adriatique (voir annexe EE), pointes qui correspondent à des périodes d'entrée d'eau plus salée provenant de la Méditerranée. On a noté ailleurs 1/ une certaine périodicité de ces intrusions et des corrélations ont été signalées précédemment entre les stocks permanents de zooplancton et la production d'oeufs d'anchois; ces corrélations ont été confirmées par de récents travaux (voir annexe FF). Si les fréquences dominantes obtenues par analyse des séries chronologiques peuvent expliquer, dans une proportion appréciable, la variance interannuelle de la production, (Regner et Gačić 2/ ont dégagé des données des périodicités de 2,5, 3,9 et environ 8 et 11 années), on doit pouvoir, jusqu'à un certain point, établir des prévisions pour la pêche, du moins en ce qui concerne les stocks pélagiques, à condition de pouvoir aussi tenir compte des effets de l'effort de pêche.

E. Méthodes acoustiques

61. Des renseignements sur la biomasse des stocks pélagiques couvrant les années 1976-1980 ont été présentés pour le côté italien de l'Adriatique (voir annexe FF); ils sont ventilés pour les anchois et les sardines (voir tableau 5), et portent sur une superficie de 7 500 km² - approximativement 20 pour cent de l'aire de répartition des ressources pélagiques. Ces valeurs ont été extrapolées pour obtenir la biomasse moyenne de la superficie totale pour l'ensemble de la période, ce qui donne 1,7 million de tonnes, dont 970 000 tonnes d'anchois et 300 000 tonnes de sardines: ces chiffres sont, selon toute probabilité, sous-estimés étant donné l'évitement des navires et le sous-dénombrement des poissons dans les couches peu profondes. En général, les résultats montrent une relation inverse entre l'abondance de la sardine et celle de l'anchois; il se pourrait que l'effet de la pêche soit plus sensible sur les stocks de sardines plus modestes.

Concernant la partie yougoslave de l'Adriatique (voir annexe GG), la biomasse pélagique a été estimée à 182 216 tonnes pour une superficie de 4 578 km² en 1982, ce qui est légèrement moins que les années précédentes.

62. Les problèmes qui se posent quand on cherche à extrapoler les données provenant d'une superficie intéressant 20 pour cent du stock, s'agissant d'un type de distribution relativement contagieux, ont été évoqués; ils sont à l'origine d'un nombre incalculable d'erreurs dans les estimations, même si la série chronologique de la biomasse concorde assez bien avec les résultats des études coopératives sur les oeufs de sardine (voir annexe HH).

F. Etude des oeufs et des larves

63. Les estimations de la biomasse et de la production potentielle de la sardine par les auteurs susmentionnés ont été calibrées par rapport à des courbes de l'intensité de reproduction établies chaque année sur un certain nombre de transects pour obtenir des estimations de la production d'oeufs sur toute l'année, d'après lesquelles on établit, compte tenu de la fécondité relative, des estimations de la biomasse du stocks reproducteur mature (voir tableau 5). Les tendances qui en résultent concernant la biomasse offrent une bonne corrélation avec les captures commerciales et montrent une ressemblance générale avec les données d'Azzali.

1/ Regner et Gačić, 1974. The fluctuations of sardine catch along the eastern Adriatic coast and solar activity. *Acta Adriat.*, vol. 14, 11, 1 - 17).

2/ S. Regner et M. Gačić, 1977. An attempt of long-term forecast of sardine catch along the eastern Adriatic coast. *Rapp. Comm. int. Mer Médit.*, 24,5 (1977).

Tableau 5: Résultats préliminaires de campagnes acoustiques: biomasses par espèces dans la zone étudiée, et extrapolées à l'aire totale de répartition du stock

Année	Méthode	Superficie prospectée	Biomasse (10 ³ tonnes)			RME	Référence
			S. pilchardus	E. encrasicolus	Biomasse totale des pélagiques, sprats compris		
1978/79 1979/80 1980/81 1981/82	Etude des oeufs	29511 Mn2	491 (218) 1 169 (344) 1 309 (501) 1 084 (424)			184 (82) 438 (179) 491 (188) 406 (159)	Regner et al.
1977/82	Prospection acoustique	4578 Mn2			192		Kačić
1976	Prospection acoustique (Superficie totale de distribution = 29500 Mn2)	8456 Mn2	58 (204)	84 (296)	192 (681)		Azzali et al.
1977		9934 "	118 (357)	101 (305)	288 (871)		
1978		3845 "	29 (230)	255 (1992)	360 (2806)		
1979							
1980	Analyse des cohortes	7099 "	48 (202)	191 (808)	348 (1472)		Levi et al.
B 1976-80		25900 "	≈ 250	≈ 830	≈ 1500	21	
1975 1976 1977 1978 1979 1980		Adriatique nord et centre jusqu'à Ancône	162 - 197 144 - 175 130 - 132 97 - 98 71 - 71 46				
1967 - 1982	Modèles de production	Côte orientale de l'Adriatique	Taille au RME: 113 Taille maximum: 236			25	Alegria

64. Au moyen de la formule $C = XMB$, on a extrapolé des estimations du rendement potentiel du stock. Il faudra parfaire cette méthode provisoire d'analyse dès que l'on aura des estimations des mortalités par âge pour le stock. A ce sujet, une méthode d'analyse des cohortes de sardines utilisant des données recueillies dans l'Adriatique nord et centrale a été présentée (voir annexe DD). Cette méthode a fourni des estimations du taux d'exploitation (dont il sera question plus loin) qui ont été comparées avec les estimations obtenues avec le modèle de production à partir de la même base de données (PESTAF).

G. Potentiel du stock pélagique et mesures d'aménagement possibles

65. La Consultation a ensuite abordé la question de la pêche au "bianchetto" (voir annexe II) qui exploite les pélagiques juvéniles le long de la côte italienne, et certains chiffres statistiques ont été présentés. Des concentrations analogues ont été remarquées dans les eaux albanaises, mais elles ne sont pas exploitées.

66. En Albanie et en Yougoslavie, ce genre de pêche est illégal. En Albanie, la pêche au chalut est interdite dans les eaux ayant moins de 50 m de profondeur. Il est possible que ce genre de pêche dans les zones littorales ait un effet sur le recrutement des petits pélagiques, et peut-être aussi sur d'autres espèces susceptibles d'être attrapées accidentellement au stade juvénile dans cette même capture, mais la forte estimation de $Z (=11,0)$ établie sur l'année, de l'oeuf au juvénile de la sardine, indique qu'une proportion appréciable de jeunes poissons disparaît par mort naturelle au stade juvénile. Il vaudrait la peine de poursuivre l'étude de cette pêche, même s'il ne s'agit que de trouver une méthode permettant de prédire le recrutement et de faire des prévisions pour la pêche.

67. La stratégie de la recherche à l'appui de l'aménagement des stocks a été évoquée. Les statistiques concernant les captures et l'effort fournissent un instrument de recherche très rentable, comparées aux études sur les oeufs et les larves et même aux prospections acoustiques, et peuvent contribuer indirectement au calibrage de ces méthodes, tout en permettant une conversion immédiate en mesures d'aménagement. On voit là encore la nécessité de bonnes statistiques.

68. La Consultation a examiné, d'une manière générale, l'application des modèles analytiques et des modèles de production aux stocks de poissons pélagiques de l'Adriatique. A l'évidence, l'application de ces modèles aux différents éléments nationaux composant une ressource commune soulève des difficultés d'interprétation, car il peut se produire des erreurs par "double comptage" contre lesquelles, en particulier dans les modèles de production, il est difficile de se prémunir. Dans une zone comme l'Adriatique, où l'on soupçonne qu'il existe deux stocks de sardines, il est certain qu'il faut tenir compte de ce fait dans les analyses, ainsi que dans les prospections de la ressource. Mais comme il est de fait que les stocks se mélangent, on s'est préoccupé de ce que des modèles globaux de ce genre puissent aboutir à des résultats trompeurs.

69. Il semble nécessaire de reprendre la définition des unités de stock pour certaines espèces et zones et, dans ces circonstances, les méthodes qui privilégient les modèles analytiques sont davantage à l'abri d'erreurs grossières. Pour ce qui est de la conception des enquêtes portant sur ce genre de stocks mélangés, il faut en déduire que ces enquêtes doivent être effectuées si possible à des époques de l'année où le mélange est minimal.

VII. PROBLEMES PARTICULIERS

A. La petite pêche côtière

70. La Consultation a examiné la question de la pêche du frai de poissons catadromes, très pratiquée dans les eaux italiennes, et des questions que ce type de pêche soulève concernant le rendement biologique des pêcheries (voir annexe JJ). Est-ce que l'existence de ce type de pêche a une incidence sur l'exploitation des adultes? De meilleurs renseignements sur les captures et sur la dimension des stocks faciliteraient peut-être l'estimation de ces incidences (voir appendice 2, qui présente une approche théorique du problème). Les évaluations de stocks doivent tenir compte de la valeur économique finale des poissons juvéniles récoltés pour les besoins de la mariculture et pour la consommation directe, ainsi que de leur valeur et de leur contribution à la pêche adulte.

71. D'autres problèmes liés à l'accès des différentes catégories de bateaux sur les fonds proches des rivages ont été mis en relief (voir annexe KK). A la lumière du problème identifié par les chercheurs italiens, à savoir que les gros chalutiers ont de plus en plus tendance à pêcher près du rivage et dans des zones où se trouve une forte proportion de classes d'âge comprises entre 0 et 1, la Consultation s'est demandée s'il ne serait pas nécessaire d'attribuer, de quelque façon, des zones et des espèces aux différentes catégories de bateaux.

72. L'analyse en grappes a montré qu'il est fréquent que plusieurs groupes d'espèces différentes coexistent tout au long de la campagne de pêche et que cela correspond également à une combinaison donnée de la biocénose, de la stratégie des chalutages et des méthodes et engins de pêche utilisés. Le caractère saisonnier et spatial de la distribution de l'effort est assez marqué, en liaison notamment avec les migrations de céphalopodes.

73. Un certain nombre d'espèces qui déposent leurs oeufs dans la zone benthique viennent frayer au printemps et en été dans des zones littorales (par exemple la crevette mantis, les gobies et plusieurs céphalopodes) et la crainte qu'une pêche aussi intensive à cette époque de l'année puisse compromettre le recrutement semble corroborée par certaines statistiques non officielles, consacrées par exemple aux tendances commerciales de l'abondance de la crevette mantis sur les marchés au poisson. Le problème semble appeler une attention urgente de la part des spécialistes de biologie marine travaillant sur l'Adriatique. Il existe bien une réglementation qui fixe le maillage à 40 mm pour cette pêche, mais, à ce jour, rien n'a été fait pour l'appliquer efficacement.

74. On a noté la forte productivité et la diversité des zones littorales peu profondes du nord de l'Adriatique, qui constituent des frayères ou des zones d'alevinage pour nombre d'espèces importantes pour les pêcheries littorales et hauturières. A l'exception de certaines circonscriptions locales, le chalutage à moins de 50 m de profondeur et de 3 milles de la côte est interdit par la loi. Depuis 1978, la pêche au chalut a été autorisée dans ces zones moyennant l'octroi de permis de pêche de portée limitée, mais la puissance des moteurs et l'effort total de pêche exercé ont alors été poussés au point de susciter des préoccupations quant à l'optimisation du rendement de la pêche. La fin de l'automne et l'hiver semblent être le seul moment où l'on ne trouve que quelques juvéniles ou adultes en train de frayer, et le stock se compose alors en grande partie de flets et d'éperlans de sable en hivernage; à cette époque de l'année, les risques de perturbation des stocks en train de frayer sont donc minimes. A d'autres époques de l'année, on y trouve d'importantes concentrations de juvéniles et d'adultes en train de frayer. Au printemps, les seiches et les encornets abondent; en été, ce sont les juvéniles de diverses espèces commerciales.

75. La variabilité des captures par espèces, selon la saison et la zone, dans les eaux littorales a été également traitée dans le cadre d'une étude du golfe de Manfredonia (voir annexe LL). Il serait très important pour l'industrie de la pêche de déterminer les périodes pendant lesquelles il faut éviter de conduire une pêche biologiquement destructive sur d'importants stocks littoraux de juvéniles et d'adultes en train de frayer, surtout s'il est possible d'adopter d'autres solutions d'aménagement, comme l'institution de périodes et de zones de fermeture, comme cela semble se faire dans certaines zones italiennes (fermeture sur 3 milles), mesures qui sont également appliquées tout au long de l'année en Albanie et en Yougoslavie.

76. On a fait allusion aux difficultés que pose l'établissement d'un indice de l'effort par "espèce recherchée" et il semble que le problème soit insurmontable en ce qui concerne la répartition de l'effort par espèces, surtout si l'obligation de présenter des rapports n'est pas observée.

77. On a décrit (voir appendice 3) une approche permettant d'estimer le taux de mortalité dû à la pêche, ventilé par engin de pêche; cette méthode implique une connaissance des modes de distribution des flottilles et des espèces, ainsi que de l'effort total. Une première estimation de ce genre indique que, compte tenu d'une journée de pêche de six à huit heures, la flottille littorale parcourt l'ensemble des fonds côtiers en l'espace de deux semaines.

B. Aménagement des zones littorales

78. On a souligné l'importance qui s'attache à définir des réglementations applicables aux zones proches du rivage et à établir des plans et des priorités nationaux par zone et par saison, qui tiennent compte des utilisations multiples et complexes de ces zones littorales pour la pêche commerciale, l'aquaculture, la mariculture (ainsi que pour une multitude d'usages autres que la pêche). Il semble donc essentiel d'adopter, à l'échelle nationale, régionale ou locale, une planification intégrée et assortie de priorités pour ces zones littorales.

79. On a évoqué la possibilité de recourir à d'autres méthodes d'évaluation pour les espèces sédentaires (par exemple *Mytilus*), telles que des estimations du taux de renouvellement ou de la productivité biologique (voir annexe MM).

C. Échantillonnage biologique

80. Aucun progrès en la matière n'a pu être signalé et la Consultation a estimé cet état de choses regrettable, d'autant qu'il serait apparemment possible d'améliorer l'évaluation des stocks littoraux

au moyen d'un programme périodique d'échantillonnage biologique. Cette méthode s'applique particulièrement aux zones littorales et est particulièrement valable si l'on considère les problèmes que pose la collecte des statistiques, notamment sur l'effort de pêche. La Consultation a donc réitéré les recommandations qu'elle avait formulées à Ancône (deuxième session) 1/.

81. On a fait observer cependant que des échantillonnages biologiques sont effectués au cours des prospections de pêche expérimentales.

D. Etudes socio-économiques

82. Une analyse coût/bénéfices de la pêche commerciale des pélagiques entreprise en coopération avec l'Université de Split fera l'objet d'un rapport qui sera présenté soit à la Conférence mondiale de la FAO sur les pêches, soit à la prochaine Consultation.

83. En 1974, une étude préliminaire des aspects socio-économiques de la pêche au chalut a été réalisée dans les eaux territoriales yougoslaves 2/.

84. Un programme d'ordinateur multifactoriel sera mis au point à Split pour étudier divers aspects de la pêche: coût, dimension du stock et effort de pêche. Une fois au point, un rapport sera présenté à son sujet à la prochaine Consultation ou à la Conférence mondiale de la FAO sur les pêches.

E. Adéquation des moyens en personnel, crédits et équipements disponibles pour des études halieutiques dans la sous-région

85. La Consultation a été informée que l'Italie n'avait rien de nouveau à signaler dans ce domaine par rapport à la deuxième Consultation. En particulier, pratiquement aucun personnel nouveau n'a pu être recruté. Toutefois, en vertu de la loi 41, dont l'un des objectifs est de développer la recherche halieutique, une partie de l'assistance nécessaire devrait pouvoir être obtenue, notamment sous forme de crédits et de moyens.

86. Pour la Yougoslavie, la situation devrait s'améliorer quelque peu dans les années à venir, tant par recrutement de personnel de recherche que par la mise à disposition de navires.

F. Problèmes de collaboration et de coordination des campagnes

87. La Consultation a noté que le problème relatif à la traversée de la ligne médiane n'est pas encore résolu, en ce qui concerne la prospection par échosondages. La Consultation a donc recommandé que les autorités compétentes fassent un effort pour résoudre ce problème. Si une solution satisfaisante pouvait être trouvée, cela permettrait de mieux couvrir l'Adriatique et par conséquent d'obtenir, au moyen des prospections par échosondage, des estimations plus précises des stocks pélagiques.

G. Recherche en commun

88. a) Océanographie - Les recherches portant sur les données contenues dans la banque de données océanographiques et qui associent la Yougoslavie et l'Italie sont en bonne voie et il est prévu d'effectuer un transect hydrographique en travers de l'Adriatique, cette année et l'année prochaine.

1/ Recommandation II - Mise en place d'un réseau d'échantillonnage biologique des débarquements

67. Cet échantillonnage s'effectue sans difficulté majeure pour les petits pélagiques en Italie. Les captures de thonidés par classes de taille (ou de poids) sont partiellement disponibles. La situation est plus critique en ce qui concerne les poissons démersaux. Aucun système d'échantillonnage des débarquements n'existe. Il est extrêmement difficile d'obtenir l'autorisation de toucher au poisson débarqué; il est pratiquement impossible de l'acheter, vu son prix élevé.

68. Cependant la Consultation a tenu à recommander que soit recherchée une solution pratique à ce problème car, sans une connaissance correcte des structures de taille des populations débarquées il est difficile, voire impossible, d'une part de réaliser les études nécessaires à la définition de schémas d'aménagement, et d'autre part de juger des résultats obtenus grâce à leur mise en oeuvre. Tous les participants ont souligné le fait que le nombre de chercheurs affectés à la recherche halieutique proprement dite était très largement insuffisant.

2/ Jukić, S., e C. Piccinetti, Influenza dei fattori biologici, tecnologici, sociali ed economici 1974 sulla pesca in Adriatico. Note Lab. Biol. Mar. Pesca, Fano, 4(9): 213-36.

89. b) Etude des ressources ichthyiques - Les deux dernières croisières, auxquelles ont participé des chercheurs italiens et yougoslaves, se sont déroulées avec succès. Il est prévu d'organiser périodiquement d'autres croisières semblables. L'analyse informatisée de ces données les rendra plus facilement accessibles aux deux instituts. Dans le cadre de la recherche coopérative, il faudrait établir, au moyen d'études des larves, le tracé des zones de reproduction et la biomasse des poissons pélagiques; ces programmes sont prêts à démarrer. Entre temps, les prospections acoustiques abandonnées en 1979 seront reprises en collaboration. Après calibrage de l'équipement acoustique, les prospections pourront s'effectuer simultanément de part et d'autre de la ligne médiane.

H. Problèmes de collaboration

90. Les représentants de la Commission des Communautés économiques européennes (CEE) ont évoqué le contexte politique dans lequel, récemment, le Parlement européen avait adopté, le 10 février 1983, une résolution concernant les initiatives que devrait prendre la Commission des Communautés européennes dans le domaine de l'aménagement des ressources halieutiques de la Méditerranée. En particulier, cette résolution exprime l'idée que l'application de mesures appropriées de conservation des ressources est fonction de la connaissance des stocks et que ces mesures sont indispensables pour assurer à long terme un rendement efficace par rapport à l'effort de pêche effectué; elle invite la Commission à soumettre au Parlement et au Conseil un programme de recherche qui permette, en trois ans, de connaître l'évolution des principales espèces vivant en Méditerranée; et elle fait part de l'intention du Parlement d'inscrire dans le budget 1984 les crédits nécessaires au déroulement de telles recherches.

91. Dans ce contexte, les représentants de la CEE ont rappelé que certaines études biologiques en Adriatique ont déjà été financées en partie par la Commission des Communautés européennes (campagnes d'inventaire des ressources démersales de mai et novembre 1982) et que la Commission des Communautés avait exprimé l'intention de favoriser le financement d'études à caractère biologique qui contribueraient à un meilleur aménagement des ressources halieutiques de l'Adriatique. Certains projets concrets ont été discutés en marge des travaux de la Consultation avec d'éventuels sous-traitants travaillant dans des institutions de recherche d'Italie. Ces projets pourraient aboutir à de telles études. Les représentants de la Commission se sont félicités de la collaboration constructive qui s'est instaurée entre scientifiques de deux pays riverains de l'Adriatique et souhaitent pouvoir contribuer encore indirectement à développer une telle coopération grâce au financement de nouvelles études. On a signalé qu'il serait utile que la Commission des Communautés européennes puisse prendre connaissance des programmes de recherche qui seraient recommandés au cours de cette consultation technique.

92. Enfin la Consultation a noté avec un grand intérêt la conclusion d'un accord entre la CEE et la FAO pour l'exécution de travaux intéressant ces deux organismes et prévus par le programme de travail du CGPM.

Ces travaux, financés par la Commission des Communautés européennes concerneront en particulier la préparation d'un manuel sur l'aménagement des lagunes côtières et l'établissement de cartes de la distribution des stocks en Méditerranée occidentale, en particulier des ressources partagées par plusieurs pays. Ils comporteront également une enquête sur les interactions entre la pêche côtière et hauturière et les activités aquacoles, étude recommandée par le colloque sur l'aménagement des ressources côtières de la Méditerranée qui s'est tenu en 1980, en liaison avec la quinzième session du CGPM.

VIII. PROGRES ACCOMPLIS EN MATIERE D'HARMONISATION DES LEGISLATIONS

93. La Consultation a noté que les négociations en cours entre l'Italie et la Yougoslavie concernant l'organisation d'entreprises mixtes de pêche et de commercialisation des poissons pélagiques et démersaux s'achèment vers une conclusion favorable. Ce nouvel aspect des relations entre les deux pays pourrait contribuer de façon importante à intensifier, dans le secteur des pêches, leurs relations déjà très bonnes; on s'attend à ce que cet accord ouvre la voie à d'autres formes de collaboration, notamment en ce qui concerne l'utilisation des ressources halieutiques pour résoudre le problème alimentaire des pays développés et des pays en développement.

94. La Consultation a également noté avec intérêt que la loi italienne No. 41 du 17 février 1982 - qui repose sur les principes d'une politique commune d'aménagement et de développement des pêches maritimes établis par le règlement CEE 3796/81 du 29 décembre 1981 - permettra d'harmoniser les activités halieutiques et scientifiques des deux pays et, donc, de faciliter leur collaboration.

IX. DATE ET LIEU DE LA PROCHAINE CONSULTATION

95. L'Institut d'océanographie et des pêches de Split s'est offert à recevoir la quatrième consultation en juin 1985. Cette invitation, qui a été accueillie avec beaucoup de plaisir et de satisfaction par les participants, sera transmise au CGPM pour qu'il l'approuve à sa dix-septième session.

X. ADOPTION DU RAPPORT

96. Le présent rapport a été adopté le 10 juin 1983.

APPENDICE 1

RAPPORT D'UN GROUPE DE TRAVAIL AD HOC SUR LES PROBLEMES DE CONCEPTION
DES PROSPECTIONS PAR CHALUTAGE DE FOND

Un petit groupe s'est constitué pour discuter de la possibilité de concevoir un programme d'échantillonnage aléatoire stratifié pour de futures prospections par chalutage.

Les avantages généraux de cette approche, comparée à l'échantillonnage systématique (par transects) sont amplement démontrés et Doubleday (1981), Doubleday et Rivard (1981) et Grosslein et Laurec (1982) en ont décrit en détail les principes 1/.

Ces avantages viennent principalement de ce qu'elle permet de faire des comparaisons valables entre données provenant de prospections successives (ou de sous-ensembles de strates) utilisant la même procédure normalisée d'échantillonnage.

En particulier, comme les limites de confiance des estimations peuvent être facilement calculées, il s'ensuit que les résultats rendent compte de plus près des populations échantillonnées. De ce fait, il est possible de calculer des intervalles de confiance pour les estimations de paramètres démographiques, comme la dimension du stock (et ses variations) et les taux de mortalité d'après la composition par taille.

Etant donné l'état relativement peu développé des statistiques halieutiques dans certaines parties de la région, il est évident que cette méthode permet d'affiner au maximum les protocoles de campagnes, compte dûment tenu de la rentabilité.

La Consultation a recommandé aux pays qui souhaitent participer à cette initiative d'envisager les activités ci-après:

1. Définir les principaux objectifs de leurs propres activités de prospections par chalutages, compte tenu de leur importance relative pour l'aménagement des stocks. Quels sont les types de renseignements les plus utiles?
 - estimations de la biomasse de la population?
 - estimations de la composition du stock par taille?
 - estimations de la répartition de la population?
 - fluctuations migratoires et cycles biologiques?
2. Préciser les moyens en personnel, crédits et navires disponibles pour la collecte et le traitement des données. Combien de stations est-il possible de traiter?
3. Effectuer une préstratification de la zone de juridiction nationale, compte tenu des zones bathymétriques pertinentes, des types de sédiments et/ou délimitations des biocénoses, ou de tout autre facteur spatial biologiquement ou économiquement important. Il faut aussi considérer que si l'on essaie de prendre en compte un trop grand nombre de facteurs, on obtiendra un tableau confus et exagérément complet, dans lequel on perdra de vue l'objectif recherché, qui est de définir un nombre limité de strates de dimensions assez uniformes qui puissent être échantillonnées au moins deux fois (pour les zones les moins importantes). L'idée générale consiste à délimiter des strates autour de zones dont on pense que, malgré la forte variabilité inhérente à toutes les données des prospections par chalutages, elles seront relativement homogènes à l'époque de l'année où la prospection par chalutages aura lieu. Il est prévu de situer les strates dans un nombre assez restreint de catégories pour lesquelles on pourra établir une fréquence d'échantillonnage relative.

1/ Doubleday W.G. (ed.), Manual on ground fish surveys in the Northwest Atlantic. NAFO Sci. Council, 1981 Stud., (2): 55 p.

Doubleday W.G. and D. Rivard (eds), Bottom trawl surveys. Relevés au chalut de fond. Can. Spec., 1981 Publ. Fish. Aquat. Sci., (58): 273 p.

Grosslein M. D., and A. Laurec, Bottom trawl surveys design, operation and analysis. CECAF/ECAF, 1982 Ser., (81/22): 25 p. Issued also in French.

Après avoir procédé à un échange de vues au sujet de programmes de stratification possibles, qui présenteraient sur toute la zone de prospection une certaine homogénéité d'approche, les services ou laboratoires nationaux devraient aussi examiner l'ordre des priorités à accorder aux différentes catégories de strates, de façon à établir une fréquence d'échantillonnage relative.

La fréquence d'échantillonnage doit, en théorie, se fonder sur la variance calculée pour chaque groupe de strates, mais il faudra aussi tenir compte de l'importance relative des différents stocks permanents d'espèces commercialement importantes dans une zone donnée.

Une fois mis au point des ensembles provisoires de strates et des fréquences relatives, on pourra ajuster la fréquence absolue d'échantillonnage en fonction des coûts, temps de navire et personnel disponibles et en tenant compte du fait qu'un plus grand nombre de traits plus courts seront plus rentables (et donneront une variance plus faible) qu'un moins grand nombre de traits longs pendant la même période. Il n'est pas essentiel d'obtenir une forte capture totale par trait de chalut - le fait de remplir au maximum les chaluts peut annuler la relation qui existe entre la dimension du stock et le taux de capture, en particulier pour les engins à petit maillage utilisés ici.

Si l'on dispose de crédits et si l'on songe à s'assurer les services d'un spécialiste de ce type de recherche, la FAO serait en mesure d'aider à trouver et à recruter cet expert.

APPENDICE 2

APPROCHE THEORIQUE AUX PROBLEMES D'AMENAGEMENT DES PECHERIES COMPORTANT DES PERIODES SUCCESSIVES D'EXPLOITATION DE LA MEME COHORTE

par

J.F. Caddy

Département des pêches, FAO, Rome

Si l'on prend comme hypothèse un stock de juvéniles comprenant N_R sujets, duquel on prélève par capture un nombre C_R de sujets, si l'on veut obtenir le nombre d'adultes survivants dt années plus tard, il faut se servir de la formule:

$$N_A = (N_R - C_R) \exp - M' dt$$

où M' représente le taux de mortalité naturelle chez les juvéniles et les adultes.

Le nombre d'adultes capturés pendant le reste de leur vie est approximativement le suivant:

$$C_{\text{adulte}} = N_A \cdot \frac{F}{Z}$$

où F/Z correspond au taux d'exploitation de la pêcherie adulte.

Cette approche devrait permettre la modélisation du coefficient Y/R de ces pêcheries, à condition d'avoir certaines données de base sur les captures et des hypothèses raisonnables quant à la valeur de dt , M' et F/Z des adultes.

APPENDICE 3

METHODE DU BALAYAGE ZONAL ET ESTIMATION D'UN INDICE DE MORTALITE PAR PECHE POUR LES PECHERIES AU SUJET DESQUELLES IL EST RELATIVEMENT DIFFICILE DE SE PROCURER DES STATISTIQUES DES CAPTURES

par

J.F. Caddy

Département des pêches, FAO, Rome

Comme il a été suggéré, il serait peut-être utile d'avoir, pour la pêcherie littorale de l'Adriatique, une méthode permettant d'estimer directement les intensités de la pêche, méthode qui comporterait la surveillance de l'effort total et la cartographie saisonnière des zones correspondant tant aux fonds de pêche qu'à la distribution des stocks d'espèces importantes. Si

$$F' = \frac{C \cdot a \cdot f}{A}$$

où f = l'effort total; C représente la partie du stock retenue sur la superficie balayée a dans la zone A , qui est la zone occupée par le stock ou le fond de pêche; F' est un indice local de la mortalité par pêche ou de l'intensité de la pêche.

Si l'on généralise pour tenir compte des types d'engins ou de navires j 1,2 ... n et de l'espèce i , on a:

$$F'_i = \sum_{j=1}^n \left[\frac{C_{ij} a_j}{A_i} \right] f_j$$

Il est possible de calculer de tels indices, même si les valeurs de C_{ij} ne sont que provisoires; ces indices seront utiles pour surveiller les pêcheries littorales.

I. INTRODUCTION

1. The Third Technical Consultation on Stock Assessment in the Adriatic took place in Fano, from 6 to 10 June 1983, at the kind invitation of the Italian Government.

2. Mr. D. Charbonnier, Secretary of GFCM, opened the meeting and thanked, on behalf of FAO, the local authorities and particularly Mr. C. Piccinetti, Director of the Fano Marine Biology and Fisheries Laboratory, for the arrangements made to facilitate the work of the meeting. He underlined the interest shown by the research workers participating in these sub-regional consultations and the appreciation of their results expressed by the Sixteenth Session of GFCM in 1982.

Prof. E. Vannini, Director of the Zoology Institute of the Bologna University, - of which the Fano laboratory depends - forwarded to the assembly the wishes of the Rector of the university for the success of this meeting whose role - he said - was essential in consideration of the economic and social importance of the fisheries in the Adriatic Sea.

Mr. A. Amati, President of the Consortium of the Fano Marine Biology and Fisheries Laboratory, welcomed the meeting from which - he added - the fishermen expected positive results. A good knowledge of the resources in fact is a prerequisite to their rational exploitation by the interested States and therefore a basis for good relationship between countries.

On behalf of the Yugoslav delegation Mr. S. Jukić thanked his Italian colleagues and the GFCM for having organized the Consultation. He recalled that its date corresponded to the tenth anniversary of the Italo-Yugoslav collaboration for the study of the resources of the Adriatic and he expressed wishes for its further development in the future.

3. The agenda reproduced in Appendix A was approved.

4. Messrs. C. Piccinetti and S. Jukić were elected Chairman and Vice-Chairman of the Consultation, respectively.

5. The list of participants is given in Appendix B.

II. PROGRESS MADE IN THE ESTABLISHMENT OF A BIOLOGICAL DATA BASE

A. Descriptive environmental variables (See Appendices D, E, F, G) 1/

6. Progress continues on the preparation of an atlas of hydrography for the Adriatic, and it is expected that the Ancona Istituto di Ricerche di Pesca Marittima (IRPEM) will have some substantive results to present on this subject by the time that the fourth technical consultation is held.

7. Discussions centered first on the problems caused by the long delays before oceanographic data are published in the region; the Consultation recommended that such information be reported promptly to interested institutes in the region, and where possible collected and reported in a standard form.

8. Environmental data may possibly be of interest to fisheries science in three principal ways:

- (i) as an index and forecasting tool for predicting short-term changes in fishing conditions and distribution of fish stocks (hence the need for prompt reporting);
- (ii) as an index of the average condition of the environment (although the need for information on extreme values of important variables was stressed as having more influence on zoogeographical changes);
- (iii) available long-term time series of important physical and biological statistics have a particular importance as indices of long-term variations or periodicities that may have an impact on recruitment and biomass fluctuations. Experience elsewhere has shown that while the impact of intensive fishing has an overriding and controllable effect on stocks, under these conditions, fluctuations in recruitment in part in response to environmental signals may be more evident than if exploitation is light.

9. The need for standardization of oceanographic data collection was raised, because of the difficulties in reconciling information collected by different methods, which renders the information difficult to use. It was recommended that a standard methodology and procedure of collecting hydrographic data be developed and used both in hydrographic and fishery cruises. Mr. Artegiani was requested to prepare a suggested procedure for measuring a limited number of important parameters, and after consultation with member institutes, and reference to research practice in other areas, to circulate this procedure to other institutes for implementation in future research vessel cruises.

1/ Documents presented to the Consultation are listed in Appendix C.

10. The need for a centralized data bank for compilation of hydrographic data was raised, and IRPEM offered to carry out this function, which will be discussed later in paragraph 88.

11. The experience obtained with the Italo-Yugoslav cooperative programme ASCOP (Adriatic Scientific Cooperation Programme) was referred to as an example of one type of standardization possible.

12. In any case, the possibility that information placed on magnetic tape can be sent to a central point for compilation was discussed. This information could then be distributed on request by the designated centre to interested institutes.

13. Other types of hydrographic data were discussed, and in particular river flow into the Adriatic, especially from the River Po (see Appendix A) since this plays a major part in determining the general circulation and salinity gradients in this sea. Long time-series of river flow data available should be compiled with other long time-series of hydrographic and selected meteorological data, and presented at the next Consultation to serve as a basis for studies on the possible impact of hydrography on fish stocks. An example of the possible impact of environment on stock size is the anchovy population, although there were opinions expressed that for most other species fishing effort is an important determinant of stock size.

14. Italian Law 979 of 31 December 1982 envisages the creation of a national data centre and monitoring of information on the marine environment (chemical and physical data). The centre will benefit from the assistance of the Istituto Centrale per la Ricerca Scientifica e Tecnologia applicata all Pesca Marittima).

B. Maps of fish populations

15. Detailed information was presented in the documents on the distribution of various species (see Appendices I, J, K) and work on a more complete atlas of fish stocks for the Adriatic should be continued on a cooperative basis, and reported to the next Consultation.

C. Summary of biological parameters

16. A large number of new estimates of population parameters were contained in papers presented to the Consultation (see Appendices L to Y). These data points are extracted by species and author in tables 1 and 2. They confirm the conclusion given later in the report (trawl surveys) of the relatively high level of mortality, and low mean ages at first capture (around age 1), as well as fairly young ages at first spawning (ages 1 - 2). A consideration of the possible impact of low survival to maturity and its impact on recruitment seems indicated from these results, and seriously merits further investigation.

17. In general, it seems that many of the species being exploited have a low L_{∞} and enter the fishery for the first time as 0 or 1 age groups, sexual maturity occurring at age 1 - 2. Although estimates of exploitation rate were heavily dependent on indirect estimates of natural mortality (Tanaka, Pauly and Taylor) ^{1/}, the level of exploitation appears in general to be quite high.

18. The problems of determining whether size frequency samples from research cruises are representative of the population or not were discussed. Systematic sampling using e.g. transects, may provide good information on distribution and seasonal movements of stocks, but the pooled information will always be somewhat suspect from the point of view of representativeness of the population as a whole if a stratified random sampling scheme is not followed in choosing individual samples to pool.

19. The need to present the source data on catch and effort in assessment documents, together with, if possible, a graph of the relationship being portrayed was emphasized, since this permits other workers to extend the analyses and make comparisons.

20. For size frequency analysis it was stressed that there are two conflicting requirements, depending on the objective of the analysis. For modal analysis, there is a need for fairly large samples, maintained separately and collected at regular intervals without pooling.

21. For analysis of mortality rates, (e.g. by catch curves, or from estimates of mean size, etc.) the need is for a so-called "stationary" size compositions representing as closely as possible an equilibrium condition in relation to prevailing fishing mortality rates. To obtain an approximation to this type of distribution, pooling of data for successive years will be necessary. These two criteria should be distinguished in work of this kind.

^{1/} Tanaka, S., 1960, Studies on the dynamics and the management of fish populations. Bull. Tokai Reg. Fish. Res. Lab., (28): 1-200.

Pauly, D., 1980, A selection of simple methods for the assessment of tropical fish stocks. FAO Fish. Circ., (729): 63 p.

Taylor, G.C., 1959, Temperature and growth. The Pacific razor clam. J. Cons. int. Explor. Mer., 25(1): 93-101.

Table 1: Length (cm) - Weight (d) relationships, condition, factors, and fecundity

SPECIES	a	b	n	Authors
<u>Squilla mantis</u> L.	M 0.0116 F 0.0138	3.0431 2.9168	71 128	Giovanardi and Piccinetti
fecundity = 50,000 eggs/female				
<u>Loligo vulgaris</u> Lam	0.04703	2.788	94	Flamini C. and Giovanardi O.
<u>Sepia officinalis</u> L.	0.22041	2.773	30	Piccinetti Manfrin G. and Giovanardi
<u>Merlangius merlangus</u> (L.)	0.00607	3.109	202	Giovanardi O. and Rizzoli M.
<u>Trisopterus minutus capellanus</u> (Risso)	0.00498	3.269	563	Tangerini P. and Arneri E.
<u>Sardina pilchardus</u> (Walb.)	0.00561	3.033	/	Sinovic G.
fecundity = 606.6 W ^{1,124}				
fecundity = 606.6 W			condition factor =	2.587 x 10 ⁻⁵
<u>Trachurus trachurus</u> (L.)	1.21 x 10 ⁻⁵	2.9176	1.726	Alegria V.
<u>Trachurus mediterraneus</u> (Steind.)	0.00555	3.105	560	Arneri E. and Tangerini P.
<u>Gobius niger</u> L.	M 0.00882 F 0.02211	3.12 2.73	1.474 875	Fabi, G. and C. Froggia
<u>Arnoglossus laterna</u> (Walb.)	M 6.83 x 10 ⁻³ F 2.08 x 10 ⁻³	3.03 3.28	38 29	Giovanardi O. and Piccinetti C.
<u>Solea vulgaris</u> Quensel	M 0.00571 F 0.00864	3.143 3.013	74 85	Piccinetti and Giovanardi O.
fecundity = 300 - 400 g female = 150,000 - 200,000 eggs/female				

Table 2: Growth and mortality rates

SPECIES (sex)	K	L _∞ (cm)	t ₀	W	Z	M	F	l _{m50} or t _{n50}	Authors
<u>Squilla mantis</u> L.								≤ 2 years	Giovanardi and Piccinetti
<u>Sepia officinalis</u> L.								1 year	
<u>Sardina pilchardus</u> Walb.	0.46	20.5	- 0.5	86.15 g	0.74	0.5 ^Δ	0.24	10+cm	Sinovic
			min. max.	min. max.	min. max.			14 cm	
<u>Sardina pilchardus</u> Walb.	0.29/0.37	18.8/19.1	- 3.0 / - 3.8	50.744 54.693	0.53 0.73	0.32 0.52	0.21		Levi et al
<u>Merluccius merluccius</u> L.	0.12	85.0	/	/	0.92	0.25	0.75		Flamigni
					1.05				
<u>Merlangius merlangus</u> L.								≤ 1 year	Giovanardi and Rizzoli
								20 cm	
<u>Trisopterus minutus capellanus</u> (Risso)								→ 1 year	Tangerini and Arneri
								13 cm	
<u>Trachurus trachurus</u> L.	0.22	37.55	1.28					15-18 cm	Alegria
<u>Trachurus mediterraneus</u> (Stein.)								≤ 2 years	Arneri and Tangerini
								> 16,8 cm	
<u>Gobius niger</u> L.								7,5/8,5cm	Fabi and Troglia
<u>Arnoglossus laterna</u> Walb.	0.572	15.812			10/11 cm	1.40 - 1.60	0.57 ^x	≥ 1 year	Giovanardi and Piccinetti
								6,8 cm	
<u>Solea vulgaris</u> Quensel	0.68	40.10			15 cm	1.4-2.0	0.9		Piccinetti and Giovanardi
							0.6 [•]		

Δ Method of Taylor (1959)

• Method of Tanaka (1960)

x Estimate from method of Pauly (1980)

22. In both cases, the importance of distinguishing data by sex for species where growth and natural mortality differ was also stressed.

23. For sedentary species (e.g. molluscs), the possibility of closing small areas to fishing in order to determine the natural mortality rate directly was discussed. Despite obvious practical difficulties, the idea seems to merit some exploration, for e.g. the vongole (Venus gallina) fishery.

24. The proportion of cartilaginous fish in the catch is an index of the local level of exploitation, since in general these are long-lived species and susceptible to high fishing rates.

III. PROGRESS IN MATTERS OF STATISTICS

A. Albania

25. The Department of Fisheries collects trawl and pelagic fisheries data. Not much information is available on the inshore fishery. Data for the small pelagic trawl fishery and the inshore fishery are separated. Sardine, hake, bogue and horse mackerel are most important economically. The grey mullet catch dominates the coastal fishery.

B. Italy

26. Data from the frame surveys on the present status of the primary fishing fleet carried out under the PESTAT programme have been placed on magnetic tape and have been given to ISTAT and EUROSTAT: they now constitute part of the official Italian data base on fishery statistics. (See Appendix Z). A series of volumes on the methodology and statistical data will be published shortly.

27. Catch and effort data have been collected for two years at a sample of sites selected on a probabilistic basis. This study, accomplished in cooperation with FAO, is a quality check on official Italian fisheries statistical data. Editing the catch and effort data, transferring them on tape and analyzing them are the next priorities. Problems of staffing and funding obviously place limitations on what can be achieved now.

28. Law 41 (passed in February 1982) now provides a framework for improvements in the implementation of data collection and the hiring of national personnel; the responsibility for collection of fishery statistics now falls under the Ministry of Merchant Marine. Law 41 states that a working group must be set up in the Istituto Centrale di Statistica to consider the feasibility of a new national fisheries statistical system on a continuing basis. The Consultation recommended this working group to recognize the importance of a correct and scientifically valid method of collecting fishery statistics for a proper assessment of stocks. This working group is urged to assist in supporting speeding implementation of such a sampling system.

29. In general, the need for proper reporting of national statistics to FAO to be included in those published in the GFCM Statistical Bulletin on a biennially updated basis was stressed, and that the resources for this vital function for subregional assessment of stocks be allocated on a national basis.

30. The Consultation reemphasized in this connection the importance of the PESTAT initiative which hopefully will be translated into a standing system for the regular collection of Italian statistics on catch-effort data in sampled ports for the species of main interest in the Adriatic.

C. Yugoslavia

31. The Yugoslav delegation stated that even if firm statistics are not available up to now for Italian fish production in the Adriatic, it has been roughly estimated that production is ten times higher than that by the Yugoslav fleet and that the Italian fleet is 10-15 times larger than the Yugoslav one. The question of overall strategy and priorities for management of the Adriatic stocks must be faced by the Consultation because of their serious implications for rational administration of the fishing industry.

32. Keeping in mind local and national disparities in degree of exploitation of Adriatic stocks, the Yugoslav delegation stressed that it is vitally important to obtain good statistics from national fleets, because of the excessive degree of exploitation currently perceived by Yugoslav assessment scientists.

33. Problems with the replacement of the internal programme of the Statistical Department in Zagreb and the retirement of staff who collected data, have adversely affected the data base for the trawl fishery.

D. Fishing effort

34. Data on the fishing effort for sardine and anchovy along the Adriatic coast of Yugoslavia are available in the form of number of days or nights fished. Some cooperatives also maintain information on trawl effort. The activity of the private sector (trawl and pelagic) is not covered under the present system.

35. For Italy, two fisheries work on a license system: for Venus gallina (vongole) and inshore trawling in the North Adriatic. Licensing requires that monthly reports of number of days at sea and catches be made. For the V. gallina fishery some degree of checking of statistics is possible for records of fishermen's organizations and fish dealers.

36. For Albania, information is collected on the number of vessels in the demersal trawl and pelagic sectors.

IV. STATE OF DEMERSAL STOCKS

A. Production model

37. No progress was reported to date with this type of approach to demersal resources, largely because of an inadequate data base.

B. Trawl surveys (see Appendix AA)

38. The joint Italy-Yugoslavia trawl surveys (in April-May and November-December 1982) with the commercial fishing vessel "Pipeta" were discussed, particularly in relation to the earlier "Hvar" (1948-49) expedition which was the last survey of this type made shortly after the Second World War when fish populations had been unexploited for some years. Stations on this cruise were along transects with higher density of stations in areas of high commercial fishing intensity in the northern and central Adriatic. Out of 80 species collected, about half (see table 3) are of commercial importance, and the greater part of the catches (over 50 percent by number) is made up of individuals of year classes 0 and 1.

39. In general, the Consultation recognized the value of continuing this collaborative effort, and discussion centered first on the definition of optimal survey strategy.

40. It was recognized that the large number of species and their seasonal variations and spatial inhomogeneity, make planning of cruises somewhat difficult, but in general November-December was believed to be the best period for regular surveys, since by then the juveniles of the year are recruited to the gear.

41. A continued series of joint cruises is planned, which in view of the shortfalls in some commercial statistics, provides the most direct method of monitoring the resource. These cruises, with the present systematic approach to selection of stations (i.e. by transects) will provide indices of abundance and their changes for important species, and we now have a better data base than was available before on species distributions. To provide estimates of biomass with confidence limits however requires the consideration of some sort of stratified survey design, and a small group met to consider the possibilities of arriving at such an overall scheme of strata for demersal trawl surveys for the Adriatic (see Annex 1).

42. Comparison of results of the "Pipeta" survey with the "Hvar" expedition, revealed a significant decline in catch rate in the interval, despite improvements in trawl gear and fishing efficiency since 1949. A report on this comparison will be made for the next consultation. In the meantime, the "Pipeta" data is being analyzed and will be made available to fishery institutes in the region. Unfortunately, the size frequency data from the earlier cruise is no longer available, since it would have provided direct estimates of M for the main species.

43. The existence of a mean age below or in the vicinity of one year of age for the recent survey was a source of preoccupation, since it is known that several important species can survive to ages 4-5 or more under low exploitation. Given an age at first retention of about 0.3-0.5 years, present mean ages correspond to values of:

$$Z = 1/(t-t_c) = (1-0.3)^{-1} - (1-0.5)^{-1}$$

i.e. in the vicinity of $Z = 1.4 - 2.0$. Assuming that natural mortality for most species is in the range $M = 0.3 - 0.8$, this indicates a high fishing mortality rate, probably even over $F = 1.0$. Evidently, further refinements of this method of analysing trawl data are necessary. For example,

Tableau 3: Espèces de l'Adriatique présentant un intérêt commercial. Rendement général moyen - Novembre 1982 1/.

Table 3: Adriatic species of commercial importance. Average general yields - November 1982 1/.

	kg/h	%
<i>Eledone moschata</i> (Lam.)	5.17	16.7
<i>Mullus barbatus</i> (L.)	3.52	11.4
<i>Trisopterus minutus capellanus</i> (Lac.)	3.35	10.9
<i>Trachurus mediterraneus</i> (Steind.)	2.02	6.6
<i>Merluccius merluccius</i> (L.)	1.55	5.0
<i>Sepia officinalis</i> (L.)	0.99	3.2
<i>Gobius niger</i> (L.)	0.94	3.0
<i>Trachurus trachurus</i> (L.)	0.88	2.8
<i>Squilla mantis</i> (L.)	0.83	2.7
<i>Merlangius merlangus</i> (L.)	0.68	2.2
<i>Pagellus erythrinus</i> (L.)	0.55	1.8
<i>Squalus acanthias</i> (L.)	0.54	1.7
<i>Lophius piscatorius</i> (L.)	0.44	1.4
<i>Loligo vulgaris</i> (Lam.)	0.41	1.3
<i>Scylliorhinus canicula</i> (L.)	0.34	1.1
<i>Raja clavata</i> (L.)	0.30	1.0
<i>Nephrops norvegicus</i> (L.)	0.28	0.9
<i>Microchirus variegatus</i> (Donovan)	0.28	0.9
<i>Conger conger</i> (L.)	0.25	0.8
<i>Mustelus asterias</i> (Cloquet)	0.22	0.7
<i>Sepia elegans</i> (d'Orbigny)	0.20	0.6
<i>Lophius budegassa</i> (Spinola)	0.15	0.5
<i>Alloteuthis media</i> (L.)	0.14	0.4
<i>Trachinus draco</i> (L.)	0.11	0.4
<i>Zeus faber</i> (L.)	0.10	0.3
<i>Trigla lyra</i> (L.)	0.09	0.3
<i>Trigla lucerna</i> (L.)	0.10	0.3
<i>Eutrigla gurnardus</i> (L.)	0.10	0.3
<i>Arnoglossus laterna</i> (Walbaum)	0.08	0.3
<i>Scorpaena scrofa</i> (L.)	0.08	0.2
<i>Lepidorhombus</i> sp.	0.07	0.2
<i>Solea vulgaris</i> (Quensel)	0.08	0.2
<i>Buglossidium luteum</i> (Risso)	0.05	0.2
<i>Penaeus kerathurus</i> (Forsk.)	0.02	0.1
<i>Uranoscopus scaber</i> (L.)	0.05	0.1
<i>Citharus macrolepidotus</i> (Bloch)	0.03	0.1
Total	24.99	80.6
Autres espèces	5.87	19.4

1/ D'après une communication de C. Piccinetti et S. Jukić / From C. Piccinetti and S. Jukić.
Considérations sur les premiers résultats de la campagne de chalutage "Pipeta".
(voir annexe AA / See Appendix AA).

it is possible to obtain an overall size frequency for each species in the research catch, and use this to obtain estimates of mortality at age (Jones size frequency analysis, FAO Fisheries Circular No. 734), and mean length (and hence mean age, if growth parameters are available), from:

$$\bar{t} = -1/K \ln \frac{(L_{\infty} - \bar{L})}{L_{\infty}} + t_0$$

as well as rough estimates of l_c and hence t_c , using the method employed in the course of the Second Consultation on Stock Assessment in the Balearic and Gulf of Lions, Statistical Divisions (FAO Fisheries Report No. 263). The only problem faced here is to be sure that the overall size frequency is representative of the population. This is difficult to say in the absence of a stratified trawl design, but the Consultation recommended that these overall size frequencies be prepared, and the necessary calculations carried out to obtain provisional estimates of $\bar{t}$ and Z in this way.

44. Preliminary analysis of the results of this cruise indicates that sediment type plays an important role in determining distribution of benthos and also of many associated fish and invertebrate species of commercial importance. (See Appendix BB). Relict sand and clayey relict sand supported the highest fish densities. Evidently, knowledge of sediment type and/or biocoenosis distribution must play an important role in future planning of trawl surveys.

C. Other methods

45. The Technical Secretary presented (See figure 1) the results of a preliminary yield per recruit analysis carried out using the yield tables of Beverton and Holt (1966) for Merluccius merluccius (L), based on the parameter estimates given in Jukić and Piccinetti (see annex L to report of the second Adriatic consultation). From experience elsewhere, the value of M for this species is probably in the range $M = 0.2 - 0.4$ and from inspection of size frequency data, l_c (size at 50 percent retention) is around 14 - 16 cm. These values were used to enter those tables in Beverton and Holt (1966) most closely corresponding to $M/K = 0.2/0.12 = 1.67$ and $M/K = 0.4/0.12 = 3.33$: i.e. those for $M/K = 1.5$ and $M/K = 3.00$.

In a more detailed yield per recruit analysis using computer programmes available for this purpose, the actual value of M/K should be used, but the tables provide a quick and useful way of integrating yield per recruit analyses for a multiple species fishery, especially where the parameter values are only known approximately (See Appendix M to the Report to the second western Mediterranean consultation). After transforming parameters to give $C = 1/l_{\infty}$ as an index of size at first capture and $E = F/Z$ (top of the table in Beverton and Holt 1966) or F/M (bottom of the table) as indices of fishing mortality the values of Y' can be read off. The quantity Y' is proportional to the yield per recruit and can be compared directly to give percent change in Y/R for any given change in C and F/M . In the example given (See Table 4 for M. merluccius and Fig. 1), the importance of a good estimate of M is evident, since although in both cases the advantage of an increase in size at first capture is clear, this would only result in a maximum of 30 percent increase in Y/R if $M = 0.4$ but as much as 180 percent if $M = 0.2$, in both cases assuming F stays the same.

Considering the effects of a change in F for the present size at first capture of Merluccius if $M = 0.4$, it appeared that the present fishing mortality rate is close to optimal. However an increase in Y/R of about 70 percent may be expected from a move to the size at first capture giving the best Y/R for the present F .

This new size at first capture would be about twice the present one (34 cm instead of 15 cm).

46. In discussion of these preliminary results, the danger of jumping immediately to conclusions relating to management of the fishery before 3 main preconditions are satisfied, was stressed, namely:

- (a) Parameter estimates and Y/R calculations must be carried out for more of the 30 important species in this multispecies fishery;
- (b) The economic impact of any change in regulations both in the short term and long term must be defined.
- (c) Better information must be obtained as to the present landings from the resource in order that any possible change caused by changes in the values of C and F in the fishery can be monitored.

With respect to analysis of seasonal length frequency data from regular, e.g. monthly, catch size frequencies, the Technical Secretary referred to the development of new methods in this area which should be available by the next consultation and are especially relevant for short lived species and seasonal fisheries.

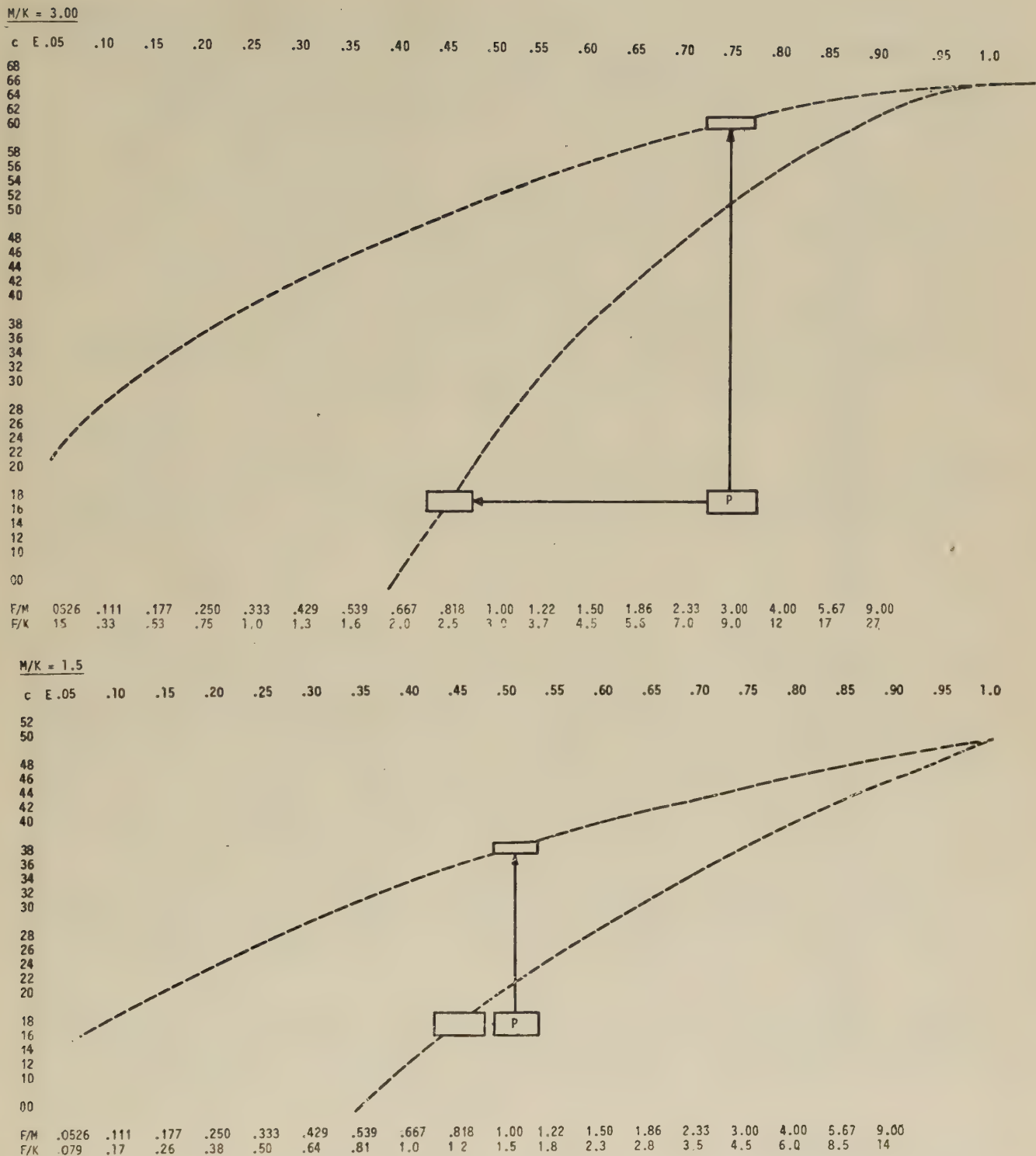


Figure 1: Yield per recruit relationships for *Merluccius merluccius* for the Adriatic under 2 different assumptions:

a) $M \hat{=} 0.2$; b) $M \hat{=} 0.4$

Arrows lead from best approximation to present status (P) of the fishery, to the exploitation rate (horizontal arrow), and to the size at first capture (vertical arrow) providing the maximum yield per recruit (other variables remaining constant).

Table 4: Illustration of the calculation of % changes in yield/recruit for Merluccius merluccius from the tables of Beverton - Holt (1966) as a result of a movement to F values giving maximum Y/R for present values of C, and to values of size at first capture, giving maximum Y/R for present values of F.

Parameters used: $K = 0.12$ $L^c = 14 - 16 \text{ cm}$ } ie $C = \frac{L^c}{L} = .165 - .188$
 $Z = 0.79$ $L^c = 85 \text{ cm}$

M =		0.2	0.4
		(ie Z - M = F = 0.59; F/M ~ 3.00)	(ie Z - M = F = 0.39; F/M ~ 1.00)
a) change in size at first capture:			
Present C = .18	From C = .16 - .18 TO C = .60	From C = .16 - .18 TO C = .38	
C = .16	From Y' = .020466 TO: Y' = .054789	Y' = .010273 TO: Y' = .013314	
Predicted change in Y/R:	From Y' = .018745	Y' = .009845	+ 32.4 %
b) change in fishing mortality rate			
Present C = .18	From F/M = 3.00 TO F/M = .818	From F/M = 1.00 TO F/M = .818	
C = .16	From Y' = .020466 TO: Y' = .033820	Present F is optimal for the given C	
Predicted change in Y/R	From Y' = .018745 TO: Y' = .0.32945		0 %
	+ 70.2 %		

D. Recommendations relative to the state of demersal stocks and intersessional research

47. Trawl surveys

- (a) Continued analysis of data from recent cooperative research cruises should aim at attempting to complete the atlas of species distribution.
- (b) Workers should also try to obtain indices of mortality rate from overall size frequency distribution for the survey area.
- (c) This objective will require information on growth rate for important species, and the fitting of von Bertalanffy growth curves.
- (d) It would also be useful to consider the distribution pattern of different age groups to help establish or confirm migration patterns with age.
- (e) A comparison of the distribution pattern, catch rates and species caught at the same stations/areas with those from the "Hvar" survey would be worth carrying out.
- (f) Further progress in exploring the possibility of developing a common bottom trawl stratification scheme should be pursued by all nations bordering the Adriatic, following the suggestions made by the ad hoc working group. (See Annex 1).

48. Yield analyses

The idea of following up the yield per recruit analyses mentioned in the report for those species for which data are available, should be considered. This will lead to more flexible methods of assessing impact of strategies of fishing on the stocks, such as the Ricker yield per recruit formulation, which is best adapted to seasonal fisheries for short - lived species. This type of methodology can also be applied to e.g. monthly size frequency samples.

V. STATE OF PELAGIC STOCKS

A. Progress as regards statistics

49. Information on fisheries statistics collection is given in section III and these conclusions apply to the pelagic fishery also: basically all countries bordering the Adriatic suffer from problems of implementing collection of fisheries statistics to an adequate level - either in initiating scientifically-based systems of data collection or in maintaining the resources to keep systems going at the desired level of completeness and accuracy. Information on fishing effort continues to be collected for those Yugoslav pelagic fishing boats working for cooperatives, but not for privately-owned vessels. Italy initiated a trial statistical data collecting system for pelagics in the Adriatic which included information on fishing effort - standardized in this case against a type of pelagic gear, the "volante" which occurs in all Italian fishing ports along the Adriatic, and this has been used as a basis for standardization.

50. This programme was stopped in December 1981 due to the departure of the research leader and the need to concentrate on data processing. During the three months preceding the Consultation, the research team acquired the necessary knowledge to continue the programme, both through training courses held at Mazara del Vallo and through data processing itself. The programme will thus start again very soon.

51. In this connection, preliminary analysis of this data revealed that vessel (shaft) horse power is the best measure of relative fishing power for the selected standard "volante" type of boat, judging from a study in a standard port, Cesenatico. The process of effort standardization was complicated by the very local range of fishing vessels and the seasonal (sequential) and spatial changes in distribution and migration of pelagic stocks along the coast.

B. Production models

52. A study of the application of production modelling to the sardine population (Sardina pilchardus Walb.) in Yugoslavia was discussed. (See Appendix CC). The estimates of MSY of around 25 000 tons and fopt of 3600 - 4 800 days fishing (exponential and linear models respectively fopt) are unchanged from an earlier fitting ^{1/} suggesting that effort has been somewhat in excess of fopt in recent years, although there is some evidence of a decline in fishing intensity in the early 1980's. Discussion centered on the cost effectiveness of this type of approach to monitoring fisheries in comparison with e.g. acoustic and egg and larval surveys.

^{1/} Alegria Hernández, V., 1981. Assessment of pelagic fish abundance along the eastern Adriatic coast with special regard to sardine (Sardina pilchardus Walb.) population. Ph. D. Thesis, Zagreb, 154 p.

53. A second production model study (see Appendix DD) of the western Adriatic fishery arrived at an estimate of MSY of 21 000 tons.

54. The small size of these two estimates in relation to acoustic and egg surveys is commented on in relation to table 5 later in this section. Application of the results of this type of study for management are discussed in section G, but in simple terms the present absence of total catch and effort data for a significant fraction of the fishery on a supposed common Adriatic resource make application of this type of model to only part of a stock difficult to interpret.

55. It was noted that the absence of effort data on part of the fishery could be overcome if complete landings were available, and if the Yugoslav catch rate data can be considered to be representative of the abundance of the whole stock.

C. Estimates of abundance and state of exploitation of the stocks

56. A variety of methods of estimating abundance and pelagic biomass were utilized, and the results of these are included in table 5 which summarizes estimates from several authors.

57. Sardine biomass estimates obtained by production modelling for the eastern Adriatic (113 - 236.10³t) or cohort analysis from northern and central Adriatic (46 - 162.10³t) are of the same order of magnitude as those obtained by acoustic methods for the whole Adriatic (250 - 103t) but they are far below the mean estimates by egg surveys (491 - 1 309.10³t).

58. For anchovy biomass few data exist, even though preliminary acoustic stock size estimates suggest stock sizes of 300 to 2 000.10³t (average 830.10³t) from 1976 to 1980 (Table 5).

59. It was noted with interest that the trends in biomass in the western Adriatic for sardine are downwards while those for the eastern Adriatic are upwards.

D. Relationship between pelagic stocks and environmental factors

60. High levels of egg production by pelagic fish stocks tend to occur following peaks in salinity in the Adriatic corresponding to periods of ingress of more saline Mediterranean water. A periodicity in the occurrence of these intrusions has been noted elsewhere ^{1/} and correlations reported earlier between standing zooplankton stock and production of anchovy eggs are confirmed by more recent work (see Appendix EE). If dominant frequencies arrived at from time series analysis can explain a significant proportion of the variance in year to year production (and Regner and Gačić ^{2/} have found periodicities of 2.5, 3.9 and about 8 and 11 years in the data) some degree of fisheries forecasting might be possible, at least for the pelagic fishery, if the effects of effort could also be taken into account.

E. Acoustic methods

61. Information on pelagic biomass in years 1976 - 1980 was presented for the Italian side of the Adriatic (see Appendix FF), broken down by anchovy and sardine (see Table 5) for an area of 7 500 nm² - roughly 20 percent of the distribution area of the pelagic resource. These values were extrapolated to the whole area to give mean biomass over the period of 1.7 million tons, with 970 000 tons anchovy and 300 000 tons of sardine identified in this total: these being in all probability under estimates, given vessel avoidance and under counting of fish in shallow layers. In general, the results show an inverse relationship between anchovy and sardine abundance, and the suggestion was made that the impact of the fishery may be greater on the smaller sardine stock.

For the Yugoslavian part of the Adriatic (see Appendix GG), the pelagic biomass was estimated for an area of 4 578 nm² as 182.216 tons for 1982, slightly below earlier years.

62. Problems of extrapolating from 20 percent stock area for a rather contagious type of distribution were discussed and constitute an unquantifiable source of error in the estimates, though the time series of biomass agrees fairly with results of cooperative sardine egg surveys (See Appendix HH).

1/ Regner S. and M. Gačić, 1974. The fluctuations of sardine catch along the eastern Adriatic coast and solar activity. *Acta Adriat.*, vol. 14, 11, 1 - 17).

2/ Regner S. and M. Gačić, 1977. An attempt of long-term forecast of sardine catch along the eastern Adriatic coast. *Rapp. Comm. int. Mer Médit.*, 24, 5 (1977).

F. Egg and larval studies

63. Estimates of biomass and potential yield of sardine by the above mentioned authors were calibrated against spawning intensity curves obtained on an annual basis from a number of transects to obtain year - round estimates of egg production from which estimates of the mature spawning stock biomass were obtained from information on relative fecundity. (See Table 5). The resulting biomass trends were well correlated with commercial catches and show a general resemblance to data of Azzali.

64. Estimates of potential yield for the stock were extrapolated from the formula $C_{max} = XMB$. This preliminary method of analysis should be refined when max estimates of mortalities at age are available for the stock. In this connection, an approach to cohort analysis of sardines from data collected in the northern and central Adriatic was presented (see Appendix DD). The method provided estimates of exploitation rate, discussed later, and were compared with production model estimates using the same (PESTAT) data base.

G. Pelagic stock potential and possible management measures

65. Discussion ensued on the "bianchetto" fishery (see Appendix II) for juvenile pelagics which occurs along the Italian coast and some figures for statistics were presented. Similar occurrences of these concentrations were noted in Albanian waters but they are not exploited.

66. Such fisheries are illegal in Albania and Yugoslavia. Trawl fishery in Albania is prohibited in water shallower than 50 m. Although there is the possibility of such fisheries in coastal areas having an impact on recruitment of small pelagics, and possibly also on other species that may be caught incidentally as juveniles in this catch, the high estimate of $Z (= 11.0)$ on an annual basis from egg to juvenile sardine indicates that a significant proportion of the young fish are lost to natural deaths in the juvenile stage. Further investigations of this fishery, even if only as a possible method of predicting recruitment and fishery forecasting, would be worthwhile.

67. The strategy for research in support of stock management was discussed. Statistics on catch and effort provide a very cost effective research tool in relation to egg and larvae and even acoustic surveys, and can provide indirect calibration of these methods, as well as immediate translation into support of management measures. This again emphasizes the need for good statistics.

68. The consultation discussed the general question of applying analytic and production models to pelagic fish stocks in the Adriatic. Clearly the problem of applying these models to national components of a common resource poses difficulties of interpretation since "double counting" errors can occur which, particularly for production models, are difficult to allow for. In an area like the Adriatic, where the existence of two stocks of sardine is suspected, this must be taken into account in analyses as well as in resource surveys. Concern was expressed that because a mixture of stocks exists, such global models will give misleading results.

69. The need for further definition of stock units for some species and areas seems indicated and methods that place emphasis on analytic models are less likely to be badly in error in these circumstances. The implications for survey design of such stock mixtures is that surveys be carried out if possible at times of year when mixing is minimal.

VII. SPECIAL PROBLEMS

A. The small-scale coastal fishery

70. The widespread existence of fisheries for the fry of catadromous fish in Italian waters was discussed (See Appendix JJ) and some of the questions of biological fishery yield these fisheries raise. Does the existence of such fisheries have an impact on the fishery for adults? Better information on catches and stock size may allow a resolution of this problem of estimation of these impacts (see Annex 2 which presents a theoretical approach to the problem). Stock assessment should take into account the eventual economic value of juvenile fish collected for mariculture purposes and direct consumption, as well as their value and contribution to adult fisheries.

71. Other problems related to access by different classes of boats to nearshore grounds were highlighted (see Appendix KK), and the need for some allocation of areas and species by class of boats was discussed in light of the problem noted by Italian scientists, of the growing tendency of larger trawlers to fish inshore, and on areas with a high proportion of 0 and 1 age classes.

72. Cluster analysis showed that several different groups of species commonly occur together throughout the fishing season and these correspond also to a combination of biocoenosis, trawling strategy and gear and fishing method used. Seasonality in distribution of effort and by area is well pronounced, especially in relation to cephalopod migrations.

Table 5: Preliminary results of acoustic surveys: Biomass by species in the survey area and extrapolated to total area covered by the stock

Year	Method	Survey area	Biomass (10 ³ tons)			MSY	Reference
			S. pilchardus	E. encrasicolus	Total (+ sprat and other pelagics)		
1978/79	Egg survey	29511 Nm2	491 (218)			184 (82)	Regner et al.
1979/80			1 169 (344)			438 (179)	
1980/81			1 309 (501)			491 (188)	
1981/82			1 084 (424)			406 (159)	
1977/82	Acoustic survey	4578 Nm2			192		Kačić
1976	Acoustic survey (Total area of distribution = 29500 Nm2)	8456 Nm2	58 (204)	84 (296)	192 (681)		Azzali et al.
1977		9934 "	118 (357)	101 (305)	288 (871)		
1978		3845 "	29 (230)	255 (1992)	360 (2806)		
1979			No data				
1980		7099 "	48 (202)	191 (808)	348 (1472)		
1976-80		25900 "	~ 250	~ 830	~ 1500		
1975	Cohort analysis	Northern and Central Adriatic down to Ancona	162 - 197				Levi et al.
1976			144 - 175				
1977			130 - 132				
1978			97 - 98			21	
1979			71 - 71				
1980			46				
1967 - 1982	Production models	Eastern adriatic coast	size at MSY: 113, maximum size: 236			25	Alegria

73. A number of species with benthic eggs spawn in spring-summer in inshore areas (e.g. mantis shrimp, gobies, several cephalopods), and the fear that such an intensive fishery at this time of year may affect recruitment appears to be supported by informal statistics on e.g. commercial trends in abundance of mantis shrimp on fish markets. This problem appears to demand urgent attention on the part of marine biologists in the Adriatic. Although a 40 mm mesh size regulation exists for this fishery, no effective enforcement exists to date.

74. The high productivity and diversity of shallow inshore areas of the northern Adriatic was noted, which form spawning and nursery areas for many species of importance to inshore and offshore fisheries. With the exception of some local authorities, trawling inside 50 m depth and within three miles of the coast was forbidden by law. Since 1978, a limited licensing of trawl fisheries in these zones has been permitted, and engine power and total effort exerted has subsequently increased to levels that give rise to concern from the point of view of optimizing fisheries yield. The late fall and winter period seems the only time when few juveniles or spawning adults are present, and the stock then largely consists of overwintering adults of sand smelt and flounder, and at this time of year the risks of disrupting spawning stocks are minimized. At other times of year, important concentrations of juveniles and spawning adults occur. In spring cuttlefish and squid, and in summer juveniles of various commercial species are abundant.

75. The variability in catches of species on a seasonal and areal basis in inshore waters was referred to also by a study in the Gulf of Manfredonia. (See Appendix LL). Defining periods during which biologically destructive fishing of important inshore juvenile and spawning adult stocks will not occur, will be of great importance to the fishing industry, especially if closed seasons and areas are feasible management alternatives, as they appear to be in some Italian areas (three mile closures), and are also applied on a year-round basis in Albania and Yugoslavia.

76. The problems of defining an index of effort by "species sought" was alluded to, and appears to pose insuperable problems in partitioning effort by species, especially if enforcement of quality of compulsory reporting is not maintained.

77. One approach to estimating the fishing mortality rate by fishing gear was outlined (see Annex 3) and depends on a knowledge of distribution patterns of fleet and species, and a knowledge of total effort. A preliminary estimate of this type suggested that with 6-8 hours per day fishing, the inshore fleet covers the inshore grounds completely over a two-week period.

B. Management of inshore areas

78. The importance of defining enforceable regulations in near shore areas was emphasized, and developing national plans and priorities by area and seasons that take into account the complex multiple usages of these inshore zones for commercial fishing, aquaculture, mariculture (as well as the multiplicity of other usages than fisheries). Integrated and prioritized planning for these inshore areas seems essential on a national, regional or local basis.

79. The possibility of using other methods of assessment for sedentary species (e.g. Mytilus) such as estimates of biological turnover or production (see Appendix MM) was referred to.

C. Biological sampling

80. No progress on this point could be referred to, and the Consultation regarded this as an unfortunate state of affairs, particularly since the possibilities of an improved assessment of inshore stock from such a regular biological sampling scheme seems feasible. This is especially feasible for inshore areas, and is particularly valid because of problems of collecting statistics, especially on fishing effort. The Consultation therefore reiterated its recommendations of the Second Ancona Consultation ^{1/}.

81. It was noted, however, that biological sampling is carried out in the course of experimental fishing surveys.

1/ Recommendation II: Establishment of a Biological Sampling Network for Landings

67. This sampling is underway for small pelagic species in Italy, and is not encountering any major problems. Tuna species catches by size (or weight) categories are partly available. The situation is more critical where demersal fish are concerned. There is no landings sampling system. It is extremely difficult to obtain authorization to deal with landed fish; it is practically impossible to buy it because of its high price.

68. However the Consultation strongly recommended that a practical solution to this problem be sought since, without sound knowledge of size structures of landed populations, it is difficult - if not impossible - to make the studies necessary for formulation of management schemes on one hand, and to judge the results obtained through their application on the other hand. All the participants emphasized the fact that the number of research workers assigned to fishery research duties as such was vastly inadequate.

D. Socio-economic studies

82. A cooperative cost-benefit analysis of the commercial pelagic fishery with the University of Split will be reported on either at the FAO World Conference on Fisheries or at the next consultation.

83. During 1974 a preliminary study of socio-economic aspects of the trawl fishery in inshore Yugoslav territorial waters was carried out ^{1/}.

84. A multi-factor computer programme will be developed in Split which will treat various aspects of the fishery: cost, stock size and fishing effort. When developed, this will be reported on at the next consultation or at the FAO World Conference on Fisheries.

E. Adequacy of staff, financial resources and equipment available for fisheries investigation in the sub-region

85. The Consultation was informed that there have not been any new developments in Italy in this respect since the second consultation. In particular, practically no new personnel could be recruited. However, Law 41, one of the aims of which is to develop fishery research, is expected to provide part of the necessary assistance, especially through the provision of financing and facilities.

86. In Yugoslavia, some improvement is expected in the coming years, both through recruitment of research personnel and provision of ship facilities.

F. Problems of collaboration and coordination of cruises

87. The Consultation noted that the problem of crossing the median line still makes difficulties as far as the echo survey is concerned. Therefore, the Consultation recommended that efforts should be made at the level of competent authorities to solve this problem. A satisfactory solution would provide better coverage of the Adriatic, and therefore more accurate estimates of pelagic stocks by echo survey.

G. Cooperative research

88. (a) Oceanography - Cooperative research on data in the oceanographic data bank is under way between Yugoslavia and Italy, and it is planned to try to carry out a hydrographic transect across the Adriatic, this and next year.

89. (b) Fish resource surveys - The last two cruises in which both Italian and Yugoslav workers were involved were carried out successfully. Similar regular cruises are planned for the future. The analysis of this data by computer will make this data easy to access for both institutes. Definition of pelagic fish spawning areas and biomass should be investigated by cooperative research using egg and larval surveys and these programmes are ready to start. In the meantime collaborative acoustic surveys left off in 1979 should be resumed. After calibration of acoustic equipment, these surveys can be carried out on each side of the median line simultaneously.

H. Problems of collaboration

90. The representatives of the Commission of the European Communities (CEC) reviewed the political context reflected recently in the resolution of the European Parliament on 10 February 1983 concerning the initiatives which the CEC should take in the field of fish resource management in the Mediterranean. In particular, the resolution expresses the idea that the application of appropriate measures for the conservation of resources can be based only on knowledge of the trend in stocks and that such measures are essential to ensure that in the long term the return is commensurate with the level of fishing activities; it invited the Commission to submit the Parliament and the Council a research programme to identify the trend of development of the main Mediterranean species within a three year period; and it announced the intention of Parliament to enter in the 1984 budget the necessary funds for carrying out such research.

91. In this context the CEC representatives recalled that some biological studies in the Adriatic have already been partly financed by the Commission of the European Communities (demersal resources inventory campaigns in May and November 1982) and that the representatives of the Commission of the European Communities have expressed their intention to promote the financing of biological studies contributing to development of better fish resources management in the Adriatic. Outside the work of the Consultation some practical projects were discussed with eventual contractors working in Italian research institutions which can conduct such studies. The representatives of the Commission expressed their satisfaction at the constructive collaboration between scientists of two

^{1/} Jukić, S. e S. Piccinetti, Influenza dei fattori biologici, tecnologici, sociali ed economici sulla pesca in Adriatico. Note Lab. Biol. Mar. Pesca, Fano, 4 (9): 213-36.
1974

Adriatic coastal countries and hoped to be able to further contribute indirectly to the development of that cooperation through financing of new studies. Emphasis was placed on the usefulness for the Commission of the European Communities to be informed of the research programmes that would be recommended during this technical consultation.

92. Lastly, the Consultation noted with great interest the conclusion of a contract agreement between the CEC and FAO for the execution of studies involving these two organizations which are planned by the GFCM programme of work. These studies financed by the Commission of the European Communities, will be aimed particularly at preparation of a manual on coastal lagoon management and maps on western Mediterranean stock distribution, especially of resources shared by several countries. They will also contain a survey on the interactions between coastal and off-shore fishery and aquaculture activities, a study recommended by the Symposium on the Management of Living Resources in the Mediterranean Coastal Area which was held in 1980 in liaison with the Fifteenth Session of the GFCM.

VIII. PROGRESS MADE IN HARMONIZATION OF LEGISLATION

93. The Consultation took note (see Appendix NN) of the perspective of a positive conclusion of the current negotiation between Italy and Yugoslavia for the establishment of joint ventures on fishery and marketing of pelagic and demersal fish. Such a development of the relations between the two countries might constitute an important element to intensify in the fisheries sector their already very good relations; it was expected that this agreement would open the way to other forms of collaboration, including the utilization of fishery resources to solve the food problem in developed and developing countries.

94. The Consultation also noted with interest that the Italian Law No. 41 of 17 February 1982 - based on the principles of a common policy for the management and development of marine fisheries established by EEC Regulation 3796/81 of 29 December 1981 - will allow the harmonization of the fishing and research activities between the two countries and therefore facilitate their collaboration.

IX. DATE AND PLACE OF THE NEXT CONSULTATION

95. An invitation was received to hold the fourth consultation at the Institute of Oceanography and Fisheries in Split, in June 1985. This offer, which was received with great pleasure and appreciation by the participants, will be submitted to the GFCM for approval at its Seventeenth Session.

X. ADOPTION OF THE REPORT

96. The present report was adopted on 10 June 1983.

ANNEX 1

REPORT OF AN AD HOC WORKING GROUP ON PROBLEMS OF BOTTOM TRAWL SURVEY DESIGN

A small group met to discuss the possibility of designing a stratified random sampling scheme for future trawl surveys.

The overall advantage of this approach in comparison with systematic sampling (e.g. transects) has been widely demonstrated, and rationales are presented in detail in Doubleday (1981), Doubleday and Rivard (1981) and Grosslein and Laurec (1982) 1/.

These advantages principally involve the validity of comparisons of data from successive surveys or subsets of strata, using the same standardized sampling procedure.

More especially the fact that confidence limits of the estimates to be readily calculated means that the results more closely reflect the populations sampled. As such, confidence intervals can be calculated for population parameter estimates of e.g. stock size (and its changes) and mortality rates from resulting size compositions.

Given the relatively underdeveloped state of fisheries statistics in parts of the region, the maximum refinement of cruise procedures with due regard to cost effectiveness is evident.

The consultation recommended that the countries wishing to participate in this initiative should consider the following activities:

1. Define the main objectives of their own fish trawl survey activities in terms of their relative importance for management of stocks. What types of information are of most importance?
 - estimates of population biomass?
 - estimates of size composition of the stock?
 - estimates of population distribution?
 - migrational and life history changes?
2. Define the availability of manpower, funds and vessels for collecting and processing the data. How many stations can be tackled?
3. Carry out a prestratification of the area of national jurisdiction in terms of relevant depth zones, sediment types and/or biocenosis boundaries, or any other biologically or economically important spatial factor. It should be borne in mind that attempting to take into consideration too many factors, will result in a confusing and over - complex picture in which the desirable goal of defining a limited number of strata of rather uniform size, which can be sampled at least twice (for the least important areas), will be lost. The general approach is that of outlining strata boundaries enclosing areas which, despite the high variability inherent in all trawl survey data, are believed to be relatively homogenous at that time of the year when the trawl survey is carried out, it is intended that strata be placed in a fairly limited number of categories for which a relative sampling frequency can be defined.

Having exchanged views on possible stratification schemes which should be consistent in approach through the survey area, national offices or laboratories should also consider what are the relative priorities to place on the different categories of strata in order to determine a relative sampling frequency.

The sampling frequency should theoretically be based on the computed variance for each group of strata, but their relative importance in terms of standing stock of commercially important species in an area needs to be given serious consideration here also.

1/ Doubleday W.G. (ed.), Manual on ground fish surveys in the Northwest Atlantic. NAFO Sci. Councl. 1981 Stud., (2): 55 p.

Doubleday W.G. and D. Rivard (eds), Bottom trawl surveys/Relevés au chalut de fond. Can. Spec. Publ. Fish. Aquat. Sci., (58): 273 p.

Grosslein M.D., and A. Laurec, Bottom trawl surveys design, operation and analysis. CECAF/ECAF Ser., (81/22): 25 p. Issued also in French.

Given that provisional sets of strata and relative frequencies have been developed, the absolute frequency of sampling may be adjusted to the limitations of cost, vessel time and manpower available, bearing in mind that a larger number of shorter tows will be more cost effective (and result in a smaller variance) than fewer long tows over the same time. (A high total catch per trawl tow is not the most important prerequisite - fishing the trawls to saturation may destroy the relationship between stock size and catch rate, especially for small mesh gears in effect here).

If the funds are available and there is interest in obtaining services of an expert in this type of research, FAO volunteered to provide assistance in location and recruitment of such an expert.

ANNEX 2

A THEORETICAL APPROACH TO PROBLEMS OF MANAGING FISHERIES WITH SUCCESSIVE PERIODS OF EXPLOITATION ON THE SAME COHORT

by

J.F. Caddy
Fisheries Department, FAO, Rome

Assuming a stock of juveniles number N_R from which capture in number C_R is taken, the number of adult survivors dt years later is given by

$$N_A = (N_R - C_R) \exp - M' dt$$

where M' is natural mortality rate between juveniles and adults.

The catch in number of adults for the rest of their life span is roughly:

$$C_{adult} = N_A \cdot \frac{F}{Z}$$

where F/Z refers to exploitation ratio in the adult fishery.

This approach should allow Y/R modelling of such fisheries, given some basic catch data and reasonable assumptions as to the value of dt , M' and adult F/Z .

ANNEX 3

AREA-SWEPT APPROACH TO ESTIMATING A FISHING MORTALITY INDEX FOR FISHERIES WHERE INFORMATION ON CATCH STATISTICS IS RELATIVELY UNAVAILABLE

by

J.F. Caddy
Fisheries Department, FAO, Rome

The suggestion is made that for the Adriatic inshore fishery, an approach to estimating fishing intensities directly may be useful, involving monitoring of total effort and seasonally mapping areas of both fishing grounds and stock distributions for important species. Given

$$F' = \frac{C \cdot a \cdot f}{A}$$

where f = total effort, C is proportion of stock retained from area swept a in stock area or fishing ground, A , F' is a local index of fishing mortality or intensity.

Generalizing for gear or vessel types j 1,2 n , for species i ,

$$F'_i = \sum_{j=1}^n \left[\frac{C_{ij} a_j}{A_i} \right] f_j$$

Such indices can be calculated, even if values of C_{ij} are only preliminary, and should be useful in monitoring inshore fisheries.

ANNEXE A

Ordre du jour

1. Ouverture de la Consultation
2. Election du président
3. Adoption de l'ordre du jour
4. Progrès accomplis dans la constitution d'une base de données biologiques
 - 4.1 Eléments descriptifs du milieu
 - 4.2 Carte des peuplements ichtyologiques
 - 4.3 Résumé des paramètres biologiques
5. Etat des stocks démersaux
 - 5.1 Progrès en matière de statistiques
 - 5.2 Mise à jour du modèle de production
 - 5.3 Prospection par chalutage
 - 5.4 Autres méthodes
 - 5.5 Conclusions et recommandations
6. Etat des stocks pélagiques
 - 6.1 Progrès en matière de statistiques
 - 6.2 Prospections acoustiques
 - 6.3 Oeufs et larves
 - 6.4 Résultats préliminaires de l'analyse de l'état des stocks
 - 6.5 Evaluation du potentiel et de l'état des stocks
7. Problèmes particuliers
 - 7.1 Petite pêche côtière
 - 7.2 Echantillonnage biologique
 - 7.3 Etudes socio-économiques
 - 7.4 Adéquation des moyens en personnel et des équipements disponibles dans la sous-région. Problèmes de collaboration/coordination aux niveaux national ou régional. Examen des programmes de recherche prévus pour 1983-85.
8. Progrès accomplis en matière d'harmonisation des législations
9. Date et lieu de la prochaine consultation
10. Autres questions
11. Adoption du rapport

APPENDIX A

Agenda

1. Opening of the Consultation
2. Election of Chairman
3. Adoption of Agenda
4. Progress made in the establishment of a biological data base
 - 4.1 Elements describing the environment
 - 4.2 Map of fish populations
 - 4.3 Summary of biological parameters
5. Status of demersal stocks
 - 5.1 Progress as regards statistics
 - 5.2 Updating of the production model
 - 5.3 Trawling surveys
 - 5.4 Other methods
 - 5.5 Conclusions and recommendations
6. Status of pelagic stocks
 - 6.1 Progress as regards statistics
 - 6.2 Acoustic surveys
 - 6.3 Eggs and larvae
 - 6.4 Preliminary results of stock assessment analysis
 - 6.5 Stock potential and status assessment
7. Special problems
 - 7.1 Small coastal fishing
 - 7.2 Biological sampling
 - 7.3 Socio-economic studies
 - 7.4 Adequacy of staff resources and equipment available in the sub-region. Problems of collaboration/coordination at national or regional level. Consideration of research programmes planned for 1983-1985
8. Progress made in harmonization of legislation
9. Date and place of the next consultation
10. Other matters
11. Adoption of the report

ANNEXE B / APPENDIX B

Liste des participants / List of participants

1. Etats Membres de la FAO / FAO Member States

V. Aléglria
Institut za ocenografiju i ribarstvo
P.P. 114
58000 Split
Yugoslavia
tel. 058-46688 / 46682

G. Andreoli
ITPP-CNR
Lungomare Fata Morgana 16/c
Mazara del Vallo (TP)
Italie
tel. 0923-948723

P. Arata
Direttore
Istituto Centrale per la Ricerca
Scientifica e Tecnologica
Applicata alla Pesca Marittima
(ICRAP)
Piazzale Porta Pia, 121
Roma
Italie
tel. 06/862828

E. Arneri
Laboratorio di Biologia Marina e di Pesca
Viale Adriatico 52
61032 Fano
Italie
tel. 0721-83689

A. Artegiani
Istituto Ricerche Pesca Marittima
(I.R.PE.M.) - CNR
Molo Mandracchio
60100 Ancona
Italie
tel. 071-204197

M. Azzali
Istituto Ricerche Pesca Marittima
(I.R.PE.M.) - CNR
Molo Mandracchio
60100 Ancona
Italie
tel. 071-204197

B. Balteza
Stacioni i Kërkimeve Shkencore të Peshkimi 1
(Station de recherche scientifique sur la
pêche / Scientific Fishery Research Station)
Durrës
Albania
tel. 25-52

P. Casali
Laboratorio di Biologia Marina e di Pesca
Viale Adriatico 52
61032 Fano
Italie
tel. 0721-83689

V.U. Ceccherelli
Istituto di Zoologia
Università di Ferrara
Via L. Borsari 46
44100 Ferrara
Italie

C. Cimmino
Istituto Centrale Ricerche Pesca
Piazzale Porta Pia 121
Roma
Italie
tel. 06-862828

N. Cingolani
Istituto Ricerche Pesca Marittima
(I.R.PE.M.) - CNR
Molo Mandracchio
60100 Ancona
Italie
tel. 071-204197

P. Colantoni
Istituto di Geologia Marina - CNR
Via Zamboni 65
40121 Bologna
Italie
tel. 051-225444

G. Colombo
Istituto di Zoologia
Università di Ferrara
Via L. Borsari 46
44100 Ferrara
Italie

G. Cosimi
Istituto Ricerche Pesca Marittima
(I.R.PE.M.) - CNR
Molo Mandracchio
60100 Ancona
Italie
tel. 071-204197

P.V. Curzi
Istituto di Geologia Marina - CNR
Via Zamboni 65
40127 Bologna
Italie
tel. 051-225444

G. Fabi
Istituto Ricerche Pesca Marittima
(I.R.PE.M.) - CNR
Molo Mandracchio
60100 Ancona
Italie
tel. 071-204197

M. Ferretti
Istituto Ricerche Pesca Marittima
(I.R.PE.M.) - CNR
Molo Mandracchio
60100 Ancona
Italie
tel. 071-204197

L. Fiorentini
Istituto Ricerche Pesca Marittima
(I.R.PE.M.) - CNR
Molo Mandracchio
60100 Ancona
Italia
tel. 071-204197

C. Flamigni
Laboratorio di Biologia Marina e di Pesca
Viale Adriatico 52
61032 Fano
Italia
tel. 0721-83689

C. Froggia
Responsabile Reparto Biologia Marina e
Oceanografia
Istituto Ricerche Pesca Marittima
Molo Mandracchio
60100 Ancona
Italia
tel. 071-204197

G. Giannetti
Istituto Ricerche Pesca Marittima
Molo Mandracchio
60100 Ancona
Italia
tel. 071-204197

S. Giannini
Istituto Ricerche Pesca Marittima
Molo Mandracchio
60100 Ancona
Italia
tel. 071-204197

M.G. Giordani
Istituto Giuridico
Università di Bologna
Via Zamboni 27-29
40100 Bologna
Italia
tel. 235464

O. Giovanardi
Laboratorio di Biologia Marina e Pesca
Viale Adriatico 52
61032 Fano
Italia
tel. 0721-83689

M.E. Gramitto
Istituto Ricerche Pesca Marittima
(I.R.PE.M.) - CNR
Molo Mandracchio
60100 Ancona
Italia
tel. 071-204197

I. Jardas
Institut za oceanografiju i ribarstvo
P.P. 114
58000 Split
Yugoslavia
tel. 058-46688/46682

S. Jukić
Institut za oceanografiju i ribarstvo
P.P. 114
58000 Split
Yugoslavia
tel. 058-46688/46682

I. Kačić
Institut za oceanografiju i ribarstvo
P.P. 114
58000 Split
Yugoslavia
tel. 058-46688/46682

E. Kapidani
Stacioni i Kërtimeve
Shkencore të Peshkimi 1
Durrës
Albanie
tel. 2552

D. Levi
I.T.P.P. - CNR
Lungomare Fata Morgana 16/c
91026 Mazara del Vallo (TP)
Italia
tel. 0923-948723/948966

P. Mengozzi
Facoltà di Giurisprudenza
Università degli Studi
Via Zamboni 27-29
40100 Bologna
tel. 051/435949

J. Mortera
Dipartimento Statistico, Probabilità e
Statistica Applicata
Università degli Studi
Roma
Italia
tel. 06/490625

G. Pagotto
Centro Chimica Metallorganico, CNR
Via Mazzolo, 9
35100 Padova
Italia
tel. 049/35205

L. Palladino
Direzione Generale della Pesca Marittima
Ministero della marina mercantile
Viale Asia
00144 Roma
Italia

C. Piccinetti
Direttore
Laboratorio di Biologia Marina e di Pesca
Viale Adriatico 52
61032 Fano
Italia
tel. 0721-83689

G. Piccinetti-Manfrin
Laboratorio di Biologia Marina e di Pesca
Viale Adriatico 52
61032 Fano
Italia
tel. 0721-83689

F. Principi
Laboratorio di Biologia Marina e di Pesca
Viale Adriatico 52
61032 Fano
Italia
tel. 0721-83689

S. Regner
Institut za oceanografiju i ribarstvo
P.P. 114
58000 Split
Yugoslavia
tel. 058-46688 / 46682

M. Rizzoli
Laboratorio di Biologia Marina e di Pesca
Viale Adriatico 52
61032 Fano
Italia
tel. 0721-83689

R. Rossi
Istituto di Zoologia
Università di Ferrara
Via L. Borsari 46
44100 Ferrara
Italia

R. Scorcelletti
Istituto Ricerche Pesca Marittima
(I.R.P.E.M.) - CNR
Molo Mandracchio
60100 Ancona
Italia
tel. 071-204197

A. Simunović
Institut za oceanografiju i ribarstvo
P.P. 114
58000 Split
Yugoslavia
tel. 058-46688 / 46682

G. Sinovčić
Institut za oceanografiju i ribarstvo
P.P. 114
58000 Split
Yugoslavia
tel. 058-46688 / 46682

M. Specchi
Istituto di Zoologia
Università di Trieste
Via Valerio 32
34100 Trieste
Italia

A. Stefanon
Istituto di Biologia del Mare
Riva 7 Martiri
Venezia
Italy
tel. 041-707622

R. Strada
Consorzio per lo Sviluppo della Pesca
ed Acquacoltura del Veneto
Via Stazione 5
30015 Chioggia (Ve)
tel. 041-404460

P. Tangerini
Laboratorio di Biologia Marina e di Pesca
Viale Adriatico 52
61032 Fano
Italia
tel. 0721-83689

N. Tegaccia
Laboratorio di Biologia Marina e di Pesca
Viale Adriatico 52
61032 Fano
Italia
tel. 0721-83689

E. Vannini
Direttore
Istituto di Zoologia
Via S. Giacomo 9
1-40126 Bologna
Italia
tel. 051-402343

T. Vučetić
Institut za oceanografiju i ribarstvo
P.P. 114
58000 Split
Yugoslavia
tel. 058-46688 / 46682

2. Commission des Communautés européennes / Commission of the European Communities

Ph. Monoyer
Expert
Direction générale de la pêche
DG XIV B1 Conservation
200 rue de la Loi
1049 Bruxelles
Belgique
tel. (32-2)-2355137

R. Noe
Administrateur
Direction générale de la pêche (XIV B1)
UPB 5/8
200 rue de la Loi
1049 Bruxelles
Belgique
tel. (32-2)-2357277

K. Vamvakas
Administrateur principal
Direction générale de la pêche
200 rue de la Loi
1049 Bruxelles
Belgique
tel. (32-2)-2355784
telex FISEU 24189
cable COMEUR BRUXELLES

3. Secrétariat CGPM/FAO/GFCM/FAO Secretariat

Département des pêches / Fisheries Department
FAO
Via delle Terme di Caracalla
00100 Rome
Italie

J.J. Caddy
Secrétaire technique de la Consultation/Technical Secretary of the Consultation

D. Charbonnier
Secrétaire du CGPM/Secretary of GFCM

G. Séfiha
Secrétaire/Secretary

ANNEXE C / APPENDIX C

Liste des documents présentés / List of documents presented

	<u>Auteurs/Authors</u>
- Advance in hydrological data base for the Adriatic Sea	A. Artegiani R. Azzolini and E. Paschini
- Application of production model to the Eastern Adriatic sardine (<u>Sardina pilchardus</u> Walb.) population	V. Alegria
- Biological data collected during the Pipeta expeditions, on the poor cod, <u>Trisopterus minutus capelanus</u> (Risso), in the Adriatic Sea	P. Tangerini and E. Arneri
- Biological data collected during the Pipeta expeditions, on the squid <u>Loligo vulgaris</u> Lam. in the Adriatic	C. Flamigni and O. Giovanardi
- Biological data collected during the Pipeta expeditions on <u>Trachurus mediterraneus</u> (Steindachner) in the Adriatic Sea	E. Arneri and P. Tangerini
- Biological data collected during the Pipeta expeditions, on the whiting, <u>Merlangius merlangus</u> (L.) in the Adriatic Sea	O. Giovanardi and M. Rizzoli
- Biology and fishery aspects of the scaldfish, <u>Arnoglossus laterna</u> (Walb.) 1792, in the Adriatic Sea	O. Giovanardi and C. Piccinetti
- Biomasse instantanée zooplanctonique et ressource pélagique	M. Specchi
- Characteristics of trawl fishery in the coastal area of the Northern Adriatic	L. Fiorentini G. Fabri, C. Frogia, S. Giannini and M.E. Gramitto
- Chronological series of hydrological data on the Northern and Central Adriatic Sea	N. Tegaccia and T. Tegaccia
- Considérations sur la pêche du "Bianchetto" (juvéniles de poissons pélagiques) dans le golfe de Manfredonia	M. Rizzoli
- Considérations sur les premiers résultats de la campagne de chalutage Pipeta	C. Piccinetti et S. Jukić
- Distribution of hake (<u>Merluccius merluccius</u> L.), striped mullet (<u>Mullus barbatus</u> L.) and pandora (<u>Pagellus erythrinus</u> L.) in the Adriatic Sea	S. Jukić and E. Arneri
- Distribution des larves du genre <u>Trachurus</u> en Adriatique	A. Guescini
- Distribution and quantity of small pelagic fish in the Eastern Adriatic - Comparison of results	I. Kačić
- Données biologiques sur <u>Solea vulgaris</u> Quensel en Adriatique	C. Piccinetti et O. Giovanardi
- Données sur la biologie de <u>Sepia officinalis</u> L. dans l'Adriatique obtenues lors des expéditions Pipeta	G. Manfrin Piccinetti et O. Giovanardi
- Données recueillies au cours des expéditions Pipeta sur la biologie de <u>Eledone moschata</u> (Lam.) en Adriatique	R. Piccinetti Manfrin et M. Rizzoli
- Estimate of spawning biomass of sardine in the Northern and Central Adriatic from 1979 to 1982 by means of egg surveys	S. Regner, C. Piccinetti and M. Specchi
- Seasonal flow rates of the Italian rivers having outlets in the Northern and in the Central Adriatic	A. Artegiani

	<u>Auteurs/Authors</u>
- Horizontal and vertical distribution of demersal Selachia (Pleurotremata, Hypotremata) in the Adriatic	I. Jardas
- Hydrographic description of the Adriatic.	M. Zore-Armanda
- Long-term fluctuations of the sardina and anchovy eggs in the Central Adriatic (1960-1982)	T. Vučetić
- Mussel exploitation from natural beds and culture parks in the Sacca di Scardovari (Po River Delta)	V.U. Ceccherelli
- Normal climatic data for the Adriatic Sea 1/	F. Stravisi
- Notes on biology and fishery of the black goby (<u>Gobius niger</u>) in the Adriatic Sea	G. Fabi and C. Frogliosi
- One year trawling survey in the coastal area of the Gulf of Manfredonia	C. Piccinetti and O. Giovanardi
- Preliminary utilization of trawl survey data for hake (<u>Merluccius merluccius</u> L.) population dynamics in the Adriatic Sea	C. Flamigni
- Progress report on the PESTAT programme: A sample survey system for the quality check of fisheries statistics	J. Mortera, D. Levi, N. Cingolani, G. Giannetti, R. Scorcelletti, E. Peloni and N. Frontini
- Programmazione nazionale e cooperazione bilaterale nella gestione delle risorse del mare Adriatico	P. Mengozzi
- Quantitative and qualitative relationship between demersal resources of the Adriatic in connection to bottom sediments and sea depth	A. Šimunović and S. Jukić
- Résumé des paramètres biologiques sur <u>Venus gallina</u> L. en Adriatique	P. Casali
- Some applications and preliminary results of acoustic methods in monitoring pelagic resources in the North and Middle Adriatic Sea	M. Azzali, G. Cosimi and M. Luna
- Some aspects of horse mackerel (<u>Trachurus trachurus</u> L.) biology in the Adriatic	V. Alegria
- A note on the fish fry fishing in the Southern area of the Po River Delta	P. Rossi
- Preliminary results on the assessment of two stocks of small pelagic fish of the Northern-Central Adriatic Sea: <u>Sardina pilchardus</u> , Walb. and <u>Engraulis encrasicolus</u>	D. Levi, N. Cingolani, G. Giannetti, R. Scorcelletti, E. Peloni and N. Frontini
- Summary of biological parameters of sardine (<u>Sardina pilchardus</u> Walb.) from the Central Adriatic	G. Sinovčić
- Summary of biological parameters of <u>Squilla mantis</u> L., in the Adriatic Sea	O. Giovanardi and G. Piccinetti Manfrin

1/ A été envoyé au Secrétariat après la réunion / Was sent to the Secretariat after the meeting.

ANNEXE D / APPENDIX D

Advance in hydrological data base for the Adriatic Sea

by

A. Artegiani, R. Azzolini and E. Paschini
IRPEM, CNR - Ancona, Italy

1. INTRODUCTION

The Adriatic Oceanographical Data Base System presented in this paper has been designed according to GFCM recommendations regarding the collection of information on the Adriatic chemico-physical characteristics and their seasonal and yearly variations in order to try and correlate them with biological parameters.

Collection of published data and standardization of codes, measure's units, are the first steps for producing tables and maps describing the reaction of the Adriatic basin to seasonal and yearly evolution of the climatic situations, both in general and separately for each zone. The data base system, both in the historical data acquisition and in their elaboration was performed by the oceanographic groups of IRPEM, Ancona, and IOR, Split.

2. DATA COLLECTION

As can be seen from table 1, a first collection of data, published in scientific papers or data reports of oceanographic surveys in the Adriatic from 1911 to 1981 - except from 1916 to 1948 - has been carried out as follows:

Table 1: Hydrological data collected between 1911 and 1981.

Names of authors(1)	or ships (2)	Years	Number of stations
Najade 2/			502
Cyclope 2/		1911-14	579
Vila Vilebita 2/			237
Hvar 2/		1948-51	29
Buljan, Zore-Armanda 1/		1952-70	2423
Trotti 1/		1965-66	184
Mosetti, Lavenia 1/		1966-67	328
Rizzoli 1/		1972	88
Mohorovićić 2/		1974-76	178
Artegiani-Azzolini 1/		1977-81	400

Data input has been executed in two phases:

- (i) Digitalization of data from literature was performed according to each author's format. Only measured parameters have been selected, omitting the calculated ones.
- (ii) Data were transformed from author's format to a standard format and to standard measure's units. They were sequentially organized in a file in such a way that they better optimize file-space size for each station.

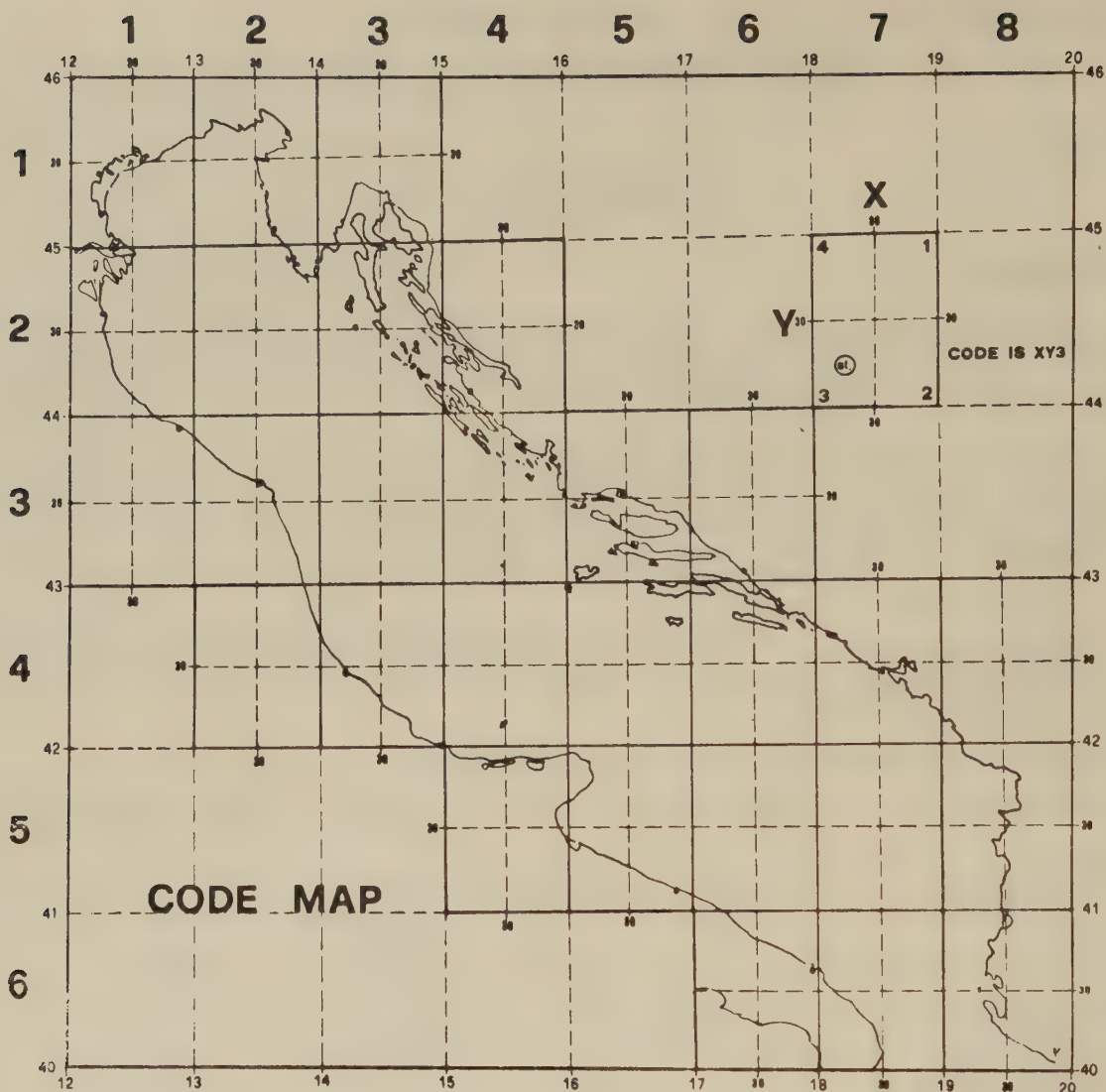


Figure 1: Code map for the Adriatic.

Two data handling routines are now working:

- (i) (POSIT) - This programme produces a map of the Adriatic in which positions and local number of stations are reported for each area, about 3°, 7' m size. Stations are previously selected from console (per month, year, author...).
- (ii) (MEAN) - This programme produces mean values at standard depths and bottom of all parameters, mean coordinates, mean sampling day and mean bottom depth for all stations in a given period and in a given square of the Code-Map (Figure 1) chosen by the operator.

ANNEXE E / APPENDIX E

Hydrographic description of the Adriatic

by

Mira Zore-Armanda

Institute of Oceanography and fisheries, Split, Yugoslavia

The Adriatic Sea was systematically investigated since the end of the last century and it exists large literature describing its hydrographic properties. General description is presented in Buljan and Zore-Armanda, 1976, and basic literature is also cited in Gilmartin and Davidson, 1971.

Description of early investigations including important expeditions such as *Najade* (1911-1914), *Ciclope* (1911-1914) and *Vila Velebita* (1913-1914) is recorded in the paper by Buljan and Zore-Armanda, 1968. Investigations on a smaller scale were continued between the two World Wars. Yugoslav oceanographers were engaged in the Mid-Dalmatian Island Area (Ercegovič, 1934), and Italian ones in the waters off the Rovinj area (Vatova, 1948).

In the last 30 years due to the rather intensive scientific activity on both coasts, the Adriatic is well described as a productive basin.

Basin morphometry influence its hydrographic properties. Adriatic is an elongated land-locked basin. Its northern part is a shallow shelf. In the South it is divided from the Ionian Sea by the 72 km wide Strait of Otranto, where there is a submarine sill at a depth of about 740 m. In the central part of the Adriatic is the Palagruza sill with a maximal depth of about 170 m. Between these two sills is located the South Adriatic basin (maximal depth 1233 m). To the north of the Palagruza sill is the Jabuka Depression (maximal depth 270 m). The surface area of the whole Adriatic amounts to 138 595 km², with an average depth of 239 m. and a volume of 34 977 km³. There are no islands on the western sandy shore, but a series of large and small ones lie off the eastern shore built preferably of limestone.

The Adriatic is a temperate warm sea (Buljan and Zore-Armanda, 1976). Temperature does not fall below 11°C even in the deepest layers. Temperature decreases with depth. At 10-30 m the thermocline occurs in the warmer part of the year. The autumn isothermal layer is recorded at 18-19°C in the southern Adriatic. In the coastal area the annual maximum is recorded in July and August and minimum in February. However, about a month's lag of the extremes is noted in the open sea. In winter, the southern Adriatic is about 8-10°C warmer than the central and northern parts. In other seasons the horizontal distribution of temperature is more uniform. The open sea is warmer than the coastal area. The long term temperature variations of the open sea are mostly due to uneven amount of the water exchange between the Adriatic and the Mediterranean. The intensified impact of the Mediterranean may increase the temperature of the open southern Adriatic by a few degrees (Zore-Armanda, 1969).

The salinity of the Adriatic is relatively high. It varies from 38.4 to 38.9 ‰ in the open southern part. In northern parts and in the coastal area the salinity is lower and shows considerably greater annual variations. The lowest salinities are found close to the mouth of the Po River. Vertical distribution in the South Adriatic Basin is similar to that in the Ionian Sea. Surface, intermediate and bottom layers are clearly distinguished. Salinity is highest in the intermediate layer. Generally two surface minimums occur in the annual course: in April-May and in December-January. First maximum appears in February-March and second (higher) in July-August along the western coast and in September-October along the eastern coast. The long-term salinity changes are due to the advection of the Eastern Mediterranean water which might be accounted for by the intensity of some climatic factors (Buljan and Zore-Armanda, 1976).

The long-term data on transparency show the lowest values in autumn, rather low values in winter and an increase in spring and summer. The waters of the open South Adriatic have the highest transparency (Tešić and Vucak, 1976; Buljan and Zore-Armanda, 1979).

The Adriatic Sea is exposed to a considerable influence of some fresh water streams. They are particularly important in the North Adriatic. The largest quantity of fresh water is added by the River Po which amounts to 600-2000 m³/sec and by other streams originating in the Alpine

regions, particularly during the season when the snow melts. A series of important investigations have been undertaken by the Italians with respect to the influence of the River Po on the adjoining area (Franco, 1973; Fossato, 1973; Scaccini-Cicatelli, 1974). Hydrographic conditions of the whole North Adriatic with respect to the influence of North Italian rivers have also been studied (Center of North Research, Rovinj, 1977; Skivanić, 1971; Malanotte Rizzoli, 1977). No large stream discharge from the eastern coast is felt with the exception of the River Drim. The hydrographic conditions prevailing in some of those estuaries were studied (Buljan, 1969; Buljan et al. 1976). Submarine springs are frequent along the eastern coast and they discharge large quantities of fresh water (Alfirević, 1979).

Vertical distribution of oxygen content shows its normal increase in the surface-bottom directions, down to the 10-40 m where the saturation is frequent. The great depths of the South Adriatic Basin are rich in oxygen since it comes there by the advection from the Northern Adriatic. There is occasional stagnation of deep waters in some coastal areas of the whole basin owing to its special form and to enrichment of surface layers with fresh water. The stagnation is mostly due to inadequate renewal through convection and advection (Buljan and Zore-Armanda, 1976).

A number of workers have investigated the nutrient salts. They are among others Ercegović (1934), Numann (1941), McGill (1970), Ilić (1969), Buljan (1969a), Buljan et al. (1975), Scaccini-Cicatelli et al. (1972), Skrivanić and Barić (1979). The highest values are found near the estuary of the River Po. Relatively high values of inorganic phosphorus are recorded in the waters off the western coast of Istria. For the middle and South Adriatic the average values amount to 2.5 - 3.0 $\mu\text{g/l PO}_4\text{-P}$. The comparison between the two Adriatic basins shows that from the surface down to 200 m the South Adriatic Basin is richer than the Jabuka Basin. This is indicative of the fact that these layers of both the Central and Southern Adriatic are enriched in phosphate coming from the South. On the contrary in the bottom layer the Jabuka Basin is the principal supplier of nutrients for the South Adriatic Basin.

The values of the inorganic nitrogen contents range in the Central and South Adriatic from 17 to 23 $\mu\text{g/l NO}_3\text{-N}$ (Buljan et al. 1975). In the northwestern Adriatic the values range between 10 - 31 $\mu\text{g/l}$. The higher content of nutrients found in upper layers of North Adriatic indicates a fluvial origin for this enrichment. The River Po discharges 28 g/sec $\text{PO}_4\text{-P}$ and 1800 g/sec of N salts.

In the South Adriatic the content of silicates ranges from 180 - 280 $\mu\text{g/l}$ and at Palagruža Sill from 140 - 280 $\mu\text{g/l}$. The Po and other rivers of the North Adriatic represent an important item in the balance of nutrients. The open South and Central Adriatic waters are poorer than the North Adriatic ones, but are poorer than those of the Ionian Sea as well. So the supply of nutrients from the Ionian Sea is also important especially during the periods of the intensified impact of Mediterranean to the Adriatic (ingressions) (Pucher-Petković and Zore-Armanda, 1973).

The circulation in the Adriatic is particularly affected by the elongated shape of this basin and its continental features (Zore-Armanda, 1963, 1968; Mosetti and Lavenia, 1969). Marked seasonal extreme temperatures and other properties, particularly in the North Adriatic are characteristic. This accounts for the corresponding seasonal variations in current regime. The open Adriatic is vertically divided into three layers: surface, intermediate and bottom. The cyclonic flow of the surface layer is in winter characterized by the prevalence of inflow with the greater speeds along the eastern coast, and in summer by the prevalence of outflow with greater speeds along the western coast. In summer and winter the density gradients between Northern and Southern Adriatic are more important than in spring and autumn and therefore the exchange of water between Northern and Southern Adriatic in the later two seasons is reduced. The North and Central Adriatic waters on one side, and the South Adriatic and Mediterranean waters on the other side meet at the Palagruža Sill. New examination of data (Zore-Armanda and Gacić, in press) shows that this zone may be understood as a frontal zone. Such observation explains rich fishing grounds in that zone.

The depth of 20 to 40 m separates the surface from the intermediate layer. The intermediate layer descends to about 200-400 m in the Central and Southern Adriatic respectively. The NW flow prevails in this layer throughout the year. In summer this flow may be understood as a flow compensatory to the SE flow in the surface layer. In winter, the same flow occurs both in the surface and intermediate layers. This inflow is compensated by the outgoing SE flow in the bottom layer. The flow intensity and the quantity of the Mediterranean water entering the Adriatic in intermediate layer vary considerably from one year to another. These variations depend on certain climatic factors in the whole of the East Mediterranean. Otherwise, the NW flow in the intermediate layer is most consistent. Its frequency in the area of Palagruža Sill amounts to 30-50 per cent.

The outflow prevails in the bottom layer. In winter the entire water column is cooled in the Northern Adriatic. This dense water flows into the bottom layer of the Jabuka Basin thence farther to the deep South Adriatic. Spreading over the Otranto Strait this water affects the bottom layer of the whole of the Eastern Mediterranean.

Determination of water types in the open Adriatic gave better insight in the way deep water is formed. Four types are defined: North, Central and South Adriatic and intermeditate eastern water originating from the Levant (Zore-Armanda, 1963). The North Adriatic water is the densest. The inflow of the larger quantities of eastern water affects salinity and temperature of the whole Adriatic and influences a number of other hydrographical and biological properties.

A numerical model has been proposed for the Northern Adriatic winter circulation taking into account evaporation, river runoff and exchange with the Southern Adriatic (Hendershott and Rizzoli, 1976).

For the East coast bora wind is very important. The upwelling recorded in winter along that coast was found to be due to the bora. The influence of the maestral wind in summer was also noted. Two layers mainly occur in the coastal area separated by a thermocline in the warmer part of the year. Current speeds are somewhat lower than in the open sea. The NW direction prevails in the surface area close to the eastern coast, however less frequent than in the open sea. Tidal currents are of small speed (4-5 cm/sec) and prevalently rotating. Cyclonic and anticyclonic flow occurs in the surface layers of the coastal basins depending on the basin's shape and wind direction. An oscillation of several days is pronounced and connected to synoptic disturbances. (Zore-Armanda et al. 1979; Zore-Armanda, in press; Gacić, 1981, in press).

In Rijeka Bay a semicircular surface water movement exists and it changes seasonally from cyclonic to anticyclonic and vice versa (Ilić et al. 1979; Jeftić et al. 1980).

The flow near the North Italian coastline is strongly influenced by the river runoff. Therefore, horizontal density gradients are much more important as well as horizontal diffusion processes responsible for the mixing of the coastal fresh river water with denser sea water. The model of the nearcoastal region has been developed (Malanotte Rizzoli and dell'Orto, 1978).

Wind waves have been studied particularly in connection to problems affecting flooding of Venice. Some numerical models of the waves propagating towards North Adriatic have been developed (Malanotte Rizzoli et al. 1972). The generation and the evolution of wind waves under the influence of strong SE wind was also studied in different parts of the Adriatic using data from three permanent stations (Smircić and Gacić, 1979, in press).

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ANNEXE F / APPENDIX F

Normal climatic data for the Adriatic Sea

by

Franco Stravisi

Istituto Talassografico di Trieste (CNR) - Trieste, Italy

ABSTRACT

The annual means of atmospheric pressure, air temperature, relative humidity, cloud amount and the precipitation totals, adjusted to the 1931-1960 last normal period, of 70 meteorological stations along the coast of the Adriatic Sea are reported.

The annual mean pressure, temperature and precipitation patterns on the sea are deduced on the basis of the above coastal conventional data.

The main average climatic features are: (i) a 3 mbar deep cyclonic area on central Adriatic, (ii) the air warming (18°C) effect of the southern and central Adriatic water cores, extending towards the Gulf of Venezia and Trieste against the cold air (13°C) intrusion from the Po Valley, (iii) the coastal rainfall intensification, mainly along the eastern Adriatic coast (up to four times the off-shore 300 mm per year), (iv) a westwards increasing cloud amount and relative humidity.

1. INTRODUCTION

In this note some climatic characteristics of the Adriatic basin are drawn on the basis of conventional meteorological data from coastal stations. It was outside the purpose of this work to carry out an exhaustive analysis of all the existing data and parameters. Some ideas on the wind distribution along the coast are given e.g. by /1,4/; general and local climatic aspects, from the nautical point of view, are reported by /5/.

As regards the meteorological elements here considered (atmospheric pressure, air temperature, relative humidity, cloud amount and total precipitation) a sufficiently wide set of data has been used. The available meteorological stations are listed in Table I: their position (Figure 1) and the source of data, with reference to the bibliography, are indicated. The Albanian stations N, 45-48 along the Ionian coast are reported to have a reference just outside the basin.

The eleven old Dalmatian stations and Pelagosa /3,6/ proved to be very well located and distributed; data of Punte Bianche (19), Scoglio Mulo (22), Scoglio Glavat (31) and Pelagosa (37) have been so far unpublished. These old data represent a high quality and complete source of informations; the rainfall normal values deduced from them very well fit with those from the recent Yugoslavian stations (6-7, 15-16, 25-26, 33-34, 37-38). The Italian data /4/ are given most of all by the "Aereonautica Militare": these have been compared with the similar AM station at Trieste, and then referred to the normal Istituto Talassografico (IT) data. Trieste (IT) has been considered as the reference station, since meteorological data are here at disposal as continuous time series since 1841.

2. DATA ADJUSTMENT

The annual mean values of the meteorological parameters have been computed, for each station, in a particular given reference period, as specified in Table I. The atmospheric pressure data have been reduced to the sea level, as well as the air temperature ($-0.66^{\circ}\text{C}/100\text{ m}$). Differences were computed between pressure, temperature and humidity annual means at each station (2-70) and the corresponding means at Trieste in the same periods; ratios were computed in the same way for the annual mean cloud amount and the precipitation totals. Using these classical so called difference and ratio methods the normal values at each station were computed with reference to the 1931-1960 normal period data of Trieste IT; the results are reported in Table I.

3. ATMOSPHERIC PRESSURE

The adjusted normal annual means of 29 stations (Table I) have been interpolated by means of sea level isobars (Figure 1).

This sketch must be taken with some caution, since the main indications about the central Adriatic low pressure area come from the Lissa (27) and Pelagosa (37) data.

The result is a cyclonic atmospheric circulation with a gradient wind up to 20 m/s in front of Gargano; a Guldberg-Mohn linear friction with a friction coefficient about $4 \times 10^{-4} \text{ s}^{-1}$ would reduce this maximum velocity to 5 m/s, folding the wind direction 75° towards the low pressure. However, it seems reasonable that an annual mean cyclonic wind is present on the Adriatic, just giving a contribution to the cyclonic surface marine circulation.

Station	[Reference]	Lat N °	Long E °	Heis. m	Reference period	Pressure mbar	Temp. °C	R.H. %	Cloud 0-10	Precip. mm
1) TRIESTE	[3,10,11]	45 39	13 45	10	1841-1983	1015.5	14.3	65	5.4	952
2) San Bartolomeo	[12]	45 36	13 44	50	1957-1965		14.5	68		890
3) Koper	[11]	45 33	13 43	33	1949-1970					970
4) Poreč	[11]	45 14	13 36	15	1949-1970					900
5) Rovinj	[11]	45 5	13 39	5	1949-1970					820
6) Pola	[3]	44 52	13 51	32	1885-1895	1014.7	14.2	74	4.5	770
7) Pula	[11]	44 52	13 51	30	1949-1970					780
8) Scoslio Porer	[3]	44 45	13 52	7	1884-1911	1014.4	15.1	78	5.5	330
9) Rijeka	[11]	45 20	14 28	104	1949-1970					1390
10) Fiume	[3]	45 19	14 27	5	1885-1895	1014.8	13.7	68	5.9	1500
11) Crikvenica	[11]	45 10	14 42	2	1949-1970					1130
12) Krk	[11]	45 2	14 35	12	1949-1970					1140
13) Senj	[11]	44 59	14 54	26	1949-1970					1220
14) Rab	[11]	44 45	14 46	24	1949-1970					990
15) Lussinpiccolo	[3]	44 32	14 28	24	1884-1895	1014.0	15.5	69	4.2	930
16) Mali Lošinj	[11]	44 32	14 28	53	1949-1970					920
17) Lussingrande	[3]	44 31	14 30	17	1889-1895		15.3		4.1	950
18) Pas	[11]	44 27	15 4	3	1949-1970					1030
19) Punta Bianche	[6]	44 9	14 49	5	1913-1917	1014.6	15.6	71	4.8	660
20) Zadar	[11]	44 8	15 13	5	1949-1970					880
21) Šibenik	[11]	43 54	15 54	77	1949-1970					790
22) Scoslio Mulo	[6]	43 31	15 55	10	1912-1918	1014.0	16.4	69	3.8	340
23) Split	[8]	43 31	16 26	122	1945-1970	1015.0	17.0	58	4.7	780
24) Makarska	[11]	43 18	17 1	14	1949-1970					1110
25) Lesina	[3]	43 11	16 27	9	1885-1895	1014.2	16.5	62	3.9	700
26) Hvar	[11]	43 10	16 27	20	1949-1970					680
27) Lissa	[3]	43 5	16 14	24	1884-1911	1013.3	16.9	74	4.2	460
28) Komiza	[11]	43 3	16 5	6	1949-1970					770
29) Vela Luka	[11]	42 58	16 43	30	1949-1970					860
30) Lastovo	[11]	42 46	16 54	186	1949-1970					640
31) Scoslio Glavat	[6]	42 46	17 9	26	1913-1917	1014.9	16.6	68	4.3	400
32) Ston	[11]	42 50	17 42	2	1949-1970					1290
33) Dubrovnik	[11]	42 39	18 6	49	1949-1970					1240
34) Ragusa	[3]	42 38	18 7	24	1884-1895	1013.9	17.2	62	4.1	1250
35) Herceg-Novi	[11]	42 27	18 32	70	1949-1970					1860
36) Punta d'Ostro	[3]	42 24	18 32	64	1884-1911	1014.3	17.1	73	5.0	870
37) Pelasosa	[6]	42 23	16 15	92	1912-1915	1012.5	16.6	73	4.3	210
38) Palasruža	[11]	42 24	16 16	82	1949-1970					260
39) Bar	[11]	42 6	19 6	3	1949-1970					1350
40) Ulcinj	[11]	41 55	19 13	97	1949-1970					1230
41) Shensjin	[2]	41 49	19 35	20	1931-1965					1650
42) Lezhe	[2]	41 47	19 38	20	1931-1965					1590
43) Durrës	[2]	41 19	19 27	15	1931-1965	1015.5	16.5		4.7	950
44) Vlore	[2]	40 27	19 29	4	1931-1965	1015.6	15.6		4.4	1120
45) Himare Spile	[2]	40 6	19 45	30	1931-1965					1620
46) Borsh	[2]	40 3	19 53	10	1931-1965		15.3		4.5	1480
47) Sarande	[2]	39 53	20 0	23	1931-1965		15.8		3.8	1460
48) Butrint	[2]	39 45	20 1	30	1931-1965					1430
49) S. Maria di Leuca	[4]	39 49	18 21	112	1960-1969	1015.2	17.4	73	4.6	680
50) Palascia	[4]	40 6	18 31	86	1960-1969	1014.9	16.7	77	4.6	570
51) Brindisi	[4]	40 39	17 57	21	1960-1969	1015.2	16.5	73	5.3	460
52) Polignano a Mare	[4]	41 0	17 13	24	1969-1979		16.5			610
53) Bari	[4]	41 8	16 47	45	1960-1969	1014.7	16.1	70	5.3	540
54) Barletta	[4]	41 19	16 17	30	1969-1979		17.7			500
55) Vieste	[4]	41 53	16 11	67	1960-1969	1015.3	16.6	77	5.0	420
56) San Nicola (Tremiti)	[4]	42 7	15 30	70	1969-1979		17.0			400
57) Lesina	[4]	41 52	15 21	5	1969-1979		15.5			600
58) Termoli	[4]	42 0	15 0	44	1960-1969	1015.6	15.9	72	4.8	360
59) Pescara	[4]	42 26	14 11	16	1960-1969	1015.3	14.1	76	5.6	570
60) Roseto degli Abruzzi	[4]	42 41	14 1	3	1969-1977					690
61) Grottammare	[4]	42 59	13 52	11	1969-1977		15.0			640
62) Ancona	[4]	42 37	13 31	105	1960-1969	1015.9	15.1	76	5.7	670
63) Falconara	[4]	43 38	13 22	9	1963-1969	1016.1	13.5	79	5.7	680
64) Rimini Miramare	[4]	44 1	12 37	11	1960-1969	1015.5	12.9	77	5.4	690
65) Cervia	[4]	44 16	12 21	17	1969-1979		12.7			680
66) Marina di Ravenna	[4]	44 29	12 17	11	1960-1969	1015.6	13.3	76	5.8	540
67) Venezia	[7]	45 26	12 19	18	1959-1972	1016.1	13.7	72	5.3	720
68) Caorle	[4]	45 36	12 54	3	1969-1979					920
69) Grado	[9]	45 41	13 24	2	1932-1941	1016.1	14.5	72	4.8	910
70) Peschiera del Timavo	[12]	45 47	13 35	5	1958-1966		13.8	70		1080

Table I - Adriatic Sea coastal meteorological stations: 1931-1960 adjusted normal climatic data (atmospheric pressure and air temperature at sea level, relative humidity and cloud amount annual means and annual precipitation totals).

The atmospheric pressure normal annual cycle is shown in Figure 3 with reference to three representative stations. An annual wave is recognized, by means of a cosine best fit analysis, with an amplitude of 1.3, 1.0, 0.8 mbar and a maximum at the beginning of November at stations N. 1 and 22 and at the end of September at station N. 37 respectively. Furthermore, a three-months period wave is observed at the same stations, with its first maximum at the end of February and an amplitude equal to 0.5, 0.9 and 0.7 mbar.

The central Adriatic depression deepens towards the cold season; the pressure difference between Trieste and Pelagosa is about 2, 3 and 4 mbar during summer, autumn and winter respectively.

4. AIR TEMPERATURE

The adjusted 1931-1960 annual mean normal isotherms (Figure 2) are drawn after the corresponding data of 40 stations in Table I. Air temperatures are reduced to the mean sea level by using the ICAO standard vertical gradient.

A question however could arise about what would this temperature represent, since coastal stations refer of course to air in a meteorological screen usually 1,5 m above the ground, not above the sea, at a site which can often be at some distance from the sea itself. A similar, often misleading, "deck effect" affects generally air temperatures measurements taken on board of ships; true air temperature (and humidity) vertical profiles above the sea surface are however quite unusual in the practice. We should therefore regard the isotherms in Figure 2 as representing the air temperature at the ground, in the conventional sense, above an ideal "flat small island" at sea level.

The southern and central Adriatic deep water cores have a clear warming effect on the annual mean air temperature. The warm maritime air spreads northwards reaching the Gulf of Trieste; colder continental air comes from the NW flat large Po Valley.

The air temperature normal annual cycle at three representative stations (Trieste, Scoglio Mulo and Pelagosa) is shown in Figure 4; the Adriatic Sea influence is evident. The maximum temperature, which at Trieste occurs at the end of July, has a delay of about 10 days at stations N. 22 and 37, with an increase smaller than 1°C; the minimum mean temperature, in late January at Trieste, occurs 20 days later at Scoglio Mulo, 30 days later at Pelagosa, with values about 5°C higher. A cosine best fit analysis shows an annual wave with an amplitude of 9.6, 7.7 and 7.5°C at stations N. 1, 22 and 37; the asymmetry in the annual cycle is accounted for by a temperature wave with a semi-annual period which has its maxima at the half of January and at the half of July, and an amplitude of 0.3, 0.6 and 0.9°C at the above stations respectively, increasing with the sea influence. The asymmetry of the annual air temperature cycle originates from a sea autumn cooling faster than the correspondent spring heating, as shown by the sea temperature behaviour in the surface layer /13/.

5. PRECIPITATION

The annual total precipitation on the Adriatic sea, adjusted to the last 1931-1960 normal period, is represented in Figure 2, according to the data of 70 coastal stations (Table I).

Even if with some degree of uncertainty, the overall situation is however clear. Off-shore precipitations reach as a mean a total of about 300 mm per year; the land influence is evident, most of all along the high eastern coast.

Table II: Distribution of the percentual partial surface of the Adriatic Sea between contour lines of equal normal annual total precipitation.

Range (mm)	Surface %	
200 - 300	18.8	Rain is mainly released in the Gulf of Drin (Albania), along southern Dalmatia, in the Rijeka Bay and in the Gulf of Trieste. According to Table II, computed after Figure 2, the weighted mean of the normal total precipitation in the Adriatic Sea is 498 mm per year.
300 - 400	23.1	
400 - 500	19.2	
500 - 600	12.3	
600 - 700	9.0	
700 - 800	6.2	Assuming then 500 ± 50 mm/a and a sea surface area equal to 1.32×10^{11} m ² , a fresh water precipitation input of $6.6 \pm 0.7 \times 10^{13}$ m ³ /a or $2.1 \pm 0.2 \times 10^6$ m ³ /s is computed for the Adriatic Sea.
800 - 900	4.3	
900 -1000	2.8	Details on the precipitation annual cycle are extensively reported by /11/ for Trieste.
1000 -1100	2.5	
1100 -1200	0.9	
1200 -1300	0.7	
1300 -1400	0.1	
1400 -1500	0.1	
	100.0	

6. RELATIVE HUMIDITY AND CLOUD AMOUNT

In Table I the normal annual mean values of relative humidity and cloud amount are reported with reference to 29 and 32 stations respectively. It is quite impossible to obtain a good spatial distribution from these data. A difference however is evident between the east coast, with an annual mean 69 ± 6 % relative humidity and a cloud amount equal to 4.4 ± 0.5 (according to the 0-10 scale) and the west coast, where the corresponding values are 75 ± 3 % and 5.3 ± 0.4 respectively.

Along the eastern Adriatic coast the air is therefore, as an average, less humid and the sky is a bit more free of clouds than along the opposite side of the basin. In the middle, an intermediate humidity value can be considered and a cloud amount about 4.0.

7. CONCLUSIONS

The ten-years averages of atmospheric pressure (at sea level), air temperature, relative humidity, precipitation and sunshine at Trieste IT are reported in Figure 5, just to have an idea of the climatic change in the last century.

The linear trends of the above time series show an overall stationary pressure, while the variations of the other parameters, per 100 years, are the following: - 0.004°C (air temperature), - 3 % (relative humidity), - 120 mm (annual total precipitation) and - 3,9 % (percentual sunshine).

Table III: Annual normal mean climatic data for the Adriatic Sea.

Atmospheric pressure m.s.l.	1014.4 ± 0.3	mbar
Air temperature m.s.l.	16.4 ± 0.3	°C
Relative humidity	72 ± 5	%
Cloud amount	4.5 ± 0.5	(0-10)
Precipitation	500 ± 50	mm/a

The annual normal values 1931-60 for the whole Adriatic Sea are reported in Table III. The pressure, temperature and precipitation spatial averages are computed after Figures 1, 2 by weighting according to the partial surfaces between the contour lines. Probable errors are indicated, accounting for observational errors, inhomogeneities between stations and for the personal error in the data interpretation process.

The climatic analysis performed in this paper represents an attempt to infer off-shore meteorological characteristics from conventional data of land stations along the Adriatic coast. Personal interpretation or deficiency apart, the weak point of such an elaboration is the poor data resolution in the central part of the basin. The only way to improve a climatic description of this kind is to have sufficiently long (3-5 years) continuous meteorological time series along the longitudinal axis of the Adriatic, and along some transverse sections. Furthermore the correlation

between the boundary layer properties above the sea and the data of a nearby coastal classical meteorological station must be carefully studied, in order to give some oceanographical significance to the overall problem.

8. ACKNOWLEDGEMENTS

I thank prof. Mario Specchi of the Trieste University who kindly compelled me to undertake this job.

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Figure 1: Adriatic Sea: meteorological stations (Table 1) and depth/m (left); 1931-1960 adjusted normal annual mean pressure/mbar at sea level (right).



Figure 2: Adriatic Sea: 1931-1960 adjusted normal annual mean temperature/°C at sea level (left) and total precipitation/mm (right).

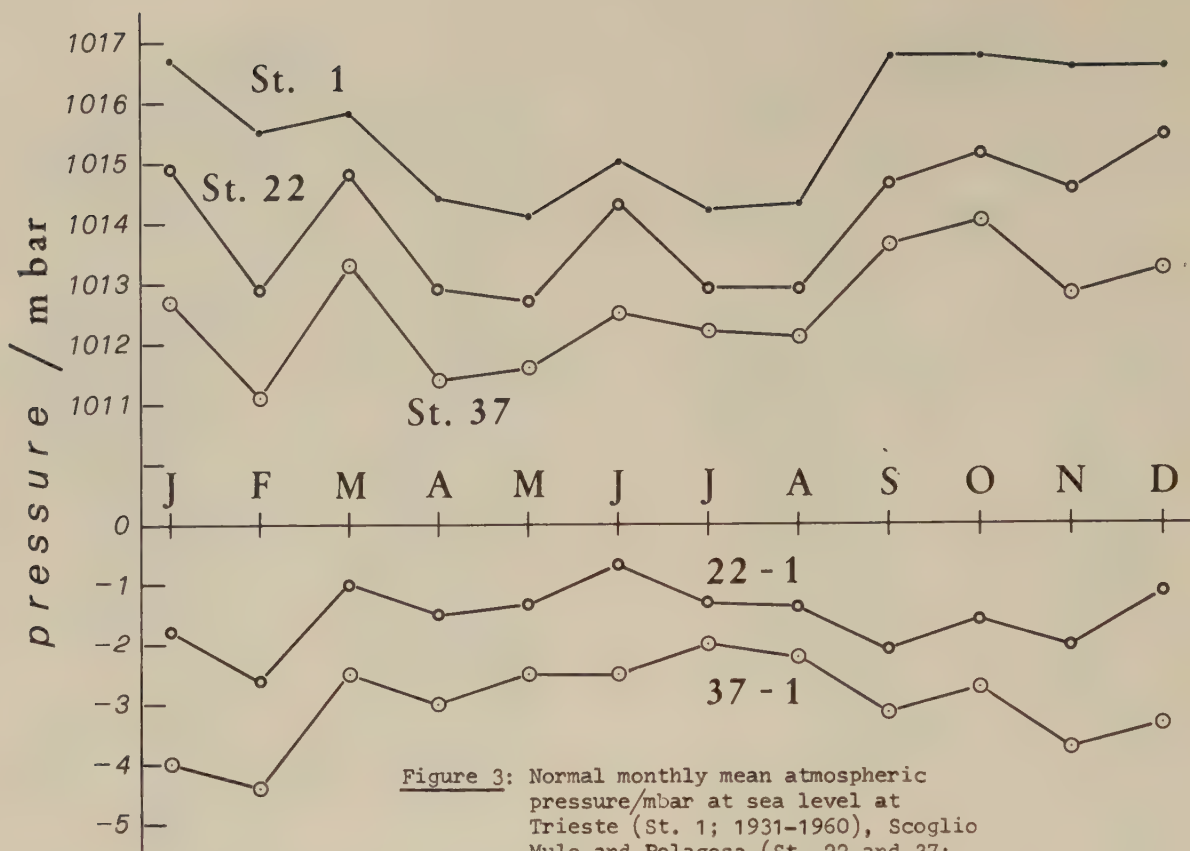


Figure 3: Normal monthly mean atmospheric pressure/mbar at sea level at Trieste (St. 1; 1931-1960), Scoglio Mulo and Pelagosa (St. 22 and 37; adjusted to 1931-1960); normal monthly mean pressure difference/mbar between Scoglio Mulo, Pelagosa and Trieste (below).

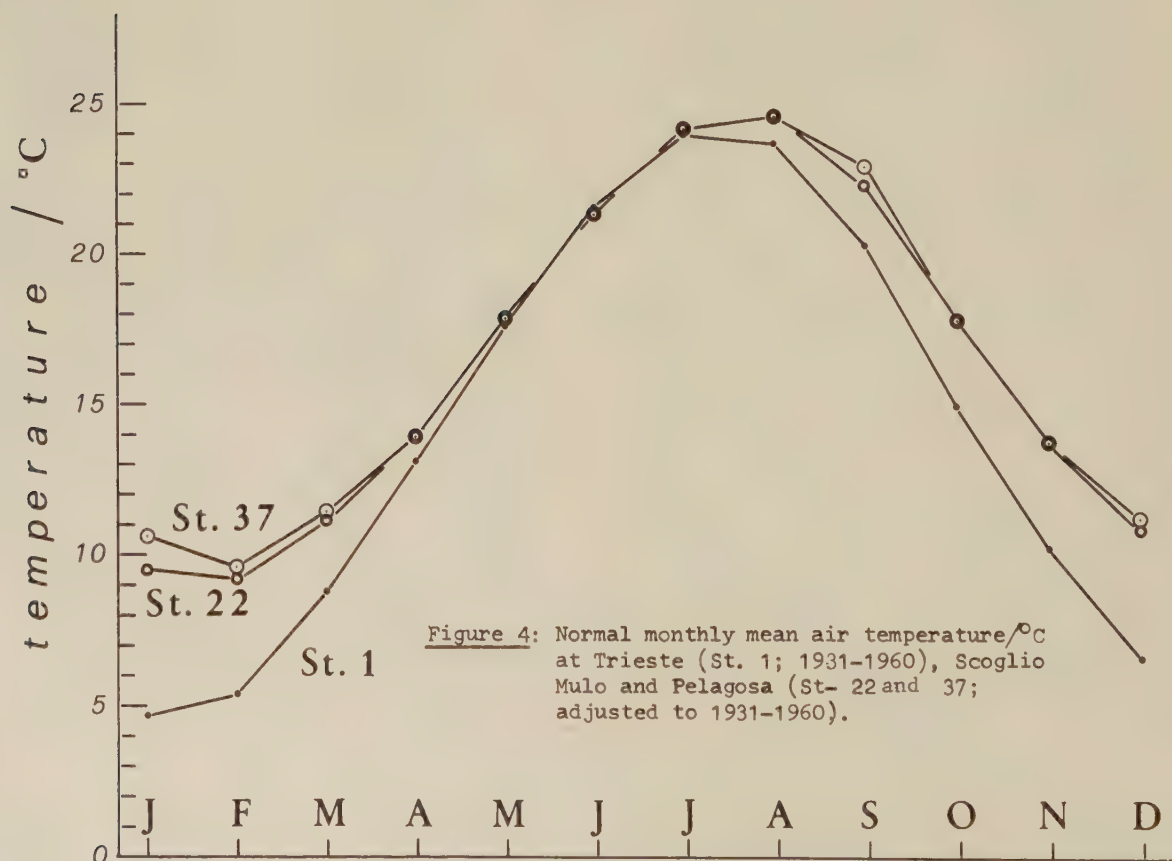


Figure 4: Normal monthly mean air temperature/°C at Trieste (St. 1; 1931-1960), Scoglio Mulo and Pelagosa (St. 22 and 37; adjusted to 1931-1960).

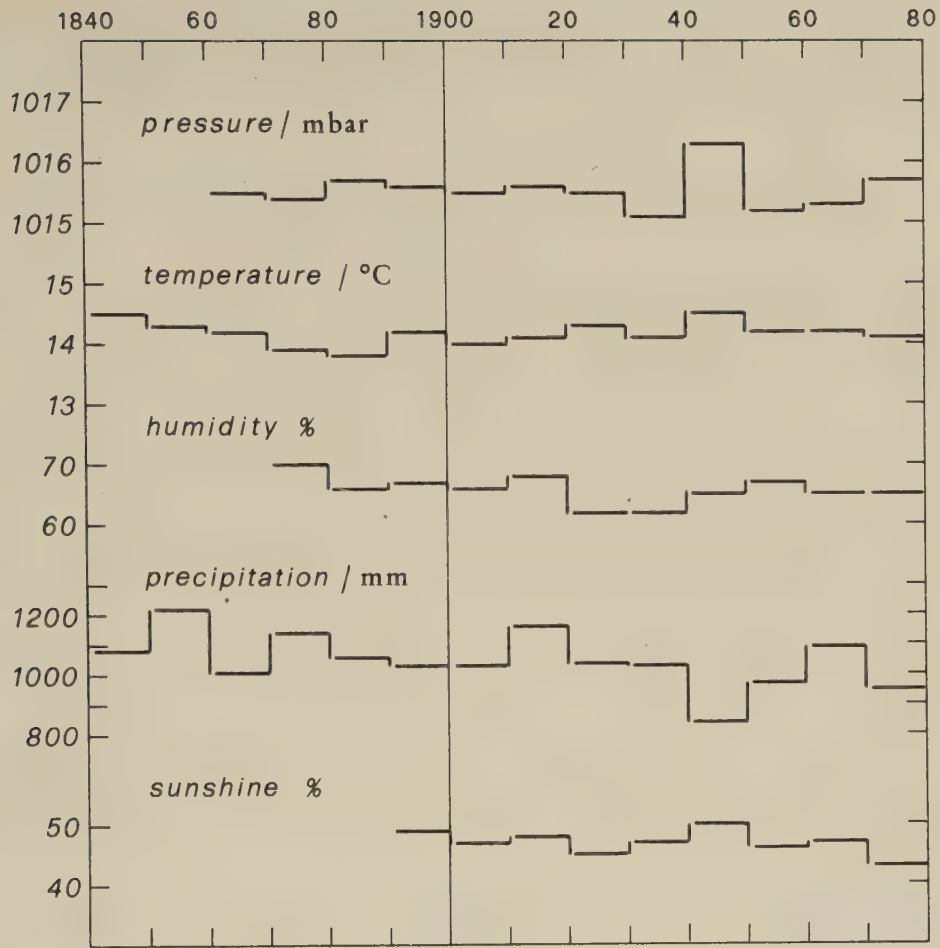


Figure 5: Trieste (Istituto Talassografico); ten-years averages of atmospheric pressure/mbar at sea level, air temperature/°C, relative humidity, annual total precipitations/mm and percentual sunshine.

ANNEXE G / APPENDIX G

Chronological series of hydrological data on the Northern and Central Adriatic Sea

by

N. Tegaccia and T. Tegaccia
Laboratorio di Biologia Marina et Pesca - Fano, Italy

For more than 30 years the Marine Biology and Fisheries Laboratory of Fano has been recording daily values of water temperature and salinity in a coastal fixed station; moreover for 5 years weekly chemical - physical data have been recorded in a fixed station at 1 mile from the coast of Fano. Such data can be used to characterize the course and the variability of some parameters.

In addition cruises have been carried out seasonally in the Northern and Central Adriatic in order to monitor the distribution and abundance of the ichthyoplankton (especially anchovy and sardine eggs and larvae) and, at the same time, to record chemico - physical data.

Here are considered data (already published) on the fixed coastal stations and results of five cruises carried out in summer and four in winter. The summer cruises, carried out in July 1978, 1979, 1980, 1981 and 1982, are constituted by 66 fixed stations on 11 radials, 30 miles being the distance between them. The mean distance between stations is 10 miles. (Figure 1).

Winter cruises, carried out in February 1979, 1980, 1981 and 1982, cover half of the Adriatic sea (western side); they were organized in the frame of an Italian - Yugoslavian cooperative programme; they covered 44 fixed stations.

The mean values of water temperature and salinity in the coastal area are reported in Table 1 (average of 29 years, 1946 - 1974). The mean values of water temperature, salinity and nutrients at a depth of 0, 5 and 10 metres on the 1 mile from the coast fixed station are reported in Table 2. They have been calculated as 5 years mean values (1967 - 1971). The mean monthly water temperature, salinity, nitrate and phosphate values relative to that period of time are reported in Figure 1.

In order to show the mean course of the hydrological conditions of the Adriatic, the superficial distribution of temperature and salinity are considered here; moreover mean values of $N - NO_3$ and $P - PO_4$, that are the major responsible of the Adriatic trophism, have been taken in account. In order to represent the mean seasonal hydrological situation of the basin the values on the maps are averaged over 5 years.

The summer situation, obtained from the means of July 1978, 1979, 1980, 1981, 1982 cruises, is given in maps of superficial distribution. Figure 2 shows water temperature (average in the first metre). Figure 3 shows salinity (‰), Figure 4 nitrate ($\mu g N-NO_3/l$), and Figure 5 phosphate ($\mu g P-PO_4/l$).

The winter situation, obtained from the means of February 1979, 1980, 1981, 1982 cruises, is given for half the Adriatic sea. The mean values distributions of the superficial water temperature, salinity, nitrates and phosphates are represented respectively in Figures 6, 7, 8 and 9.

These maps give a general idea of the Adriatic hydrology during the considered seasons and years; the situation is very dynamic and is influenced by many, especially meteorological, factors.

The mean values of 5 years have been considered since they are representative of a mean hydrological situation that is not significantly far from the single year courses.

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Table 1: Mean monthly water temperature and salinity in the Fano fixed coastal station from 1946 to 1974.

MONTHS	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
T °C monthly means	6.43	7.22	9.63	13.66	17.82	21.90	24.77	25.03	22.44	17.92	13.26	8.88
S ‰ monthly means	32.27	32.69	32.48	33.34	33.49	34.00	34.41	35.27	35.13	34.24	33.28	32.33

Table 2: Mean annual values of water temperature, salinity, nitrates and phosphates at 3 depths on the fixed station 1 mile from the coast.

Parameters	years depth	1967	1968	1969	1970	1971	5 years mean values
T °C	0 m.	16.43	15.97	15.88	15.57	15.59	15.89
	5 m.	16.04	15.73	15.47	15.43	15.06	15.55
	10 m.	15.92	15.69	15.47	15.32	14.95	15.47
S ‰	0 m.	34.19	33.69	33.26	34.07	33.47	33.74
	5 m.	34.98	34.95	34.22	35.01	34.58	34.75
	10 m.	35.61	35.68	35.45	35.59	35.76	35.62
N-NO ₃ μg/l	0 m.	82.67	70.08	141.58	117.50	143.08	110.98
	5 m.	70.50	52.00	100.33	77.50	126.33	85.33
	10 m.	71.00	51.50	69.83	72.00	108.17	74.50
P-PO ₄ μg/l	0 m.	9.28	3.26	2.81	3.54	3.45	4.47
	5 m.	9.07	2.98	2.58	5.01	3.08	4.54
	10 m.	8.83	3.18	2.94	4.34	2.85	4.43

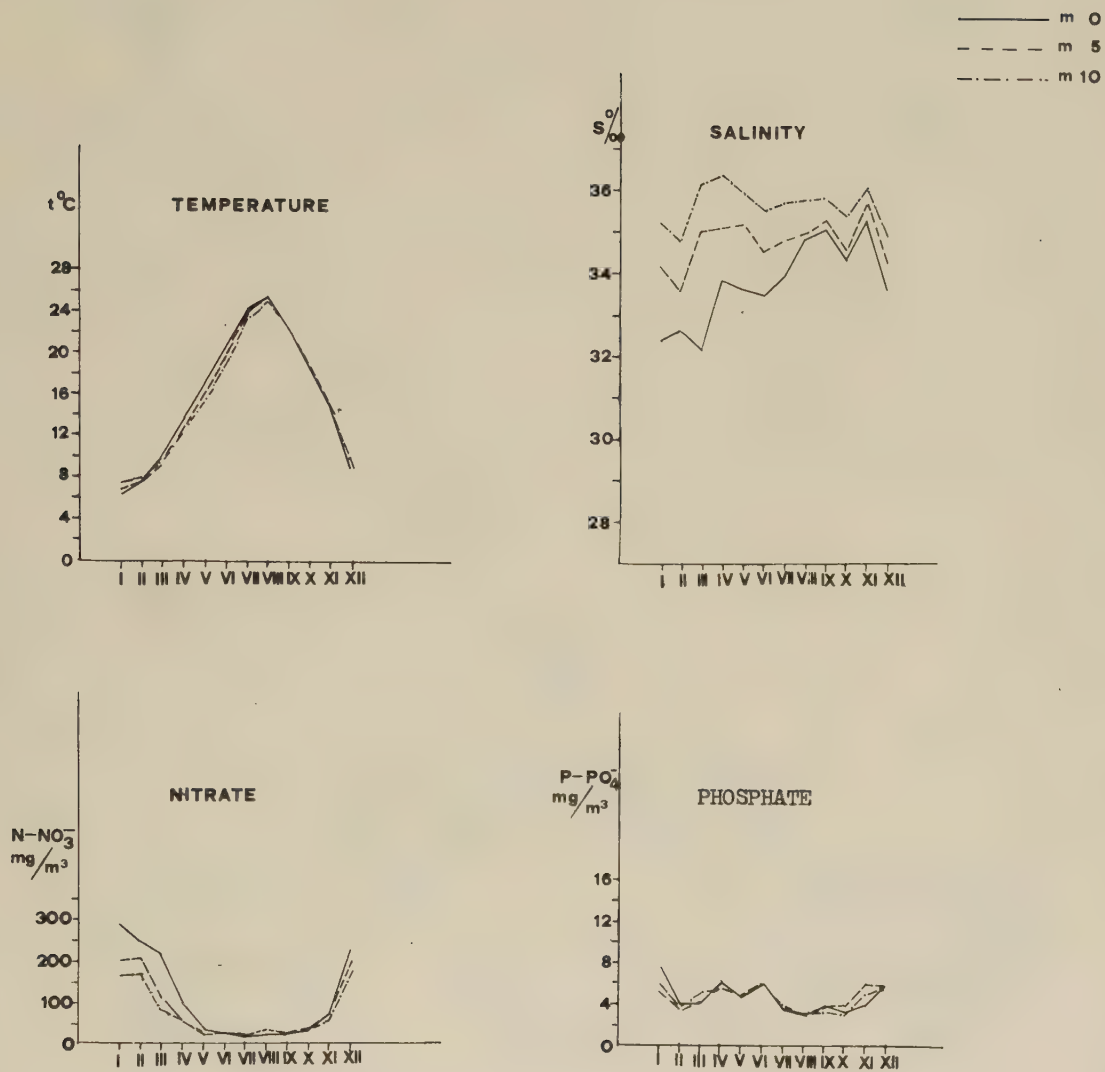


Figure 1: Mean monthly water temperature, salinity, nitrates and phosphate (average 1967-1971) in a fixed station at 1 mile from the coast of Fano.

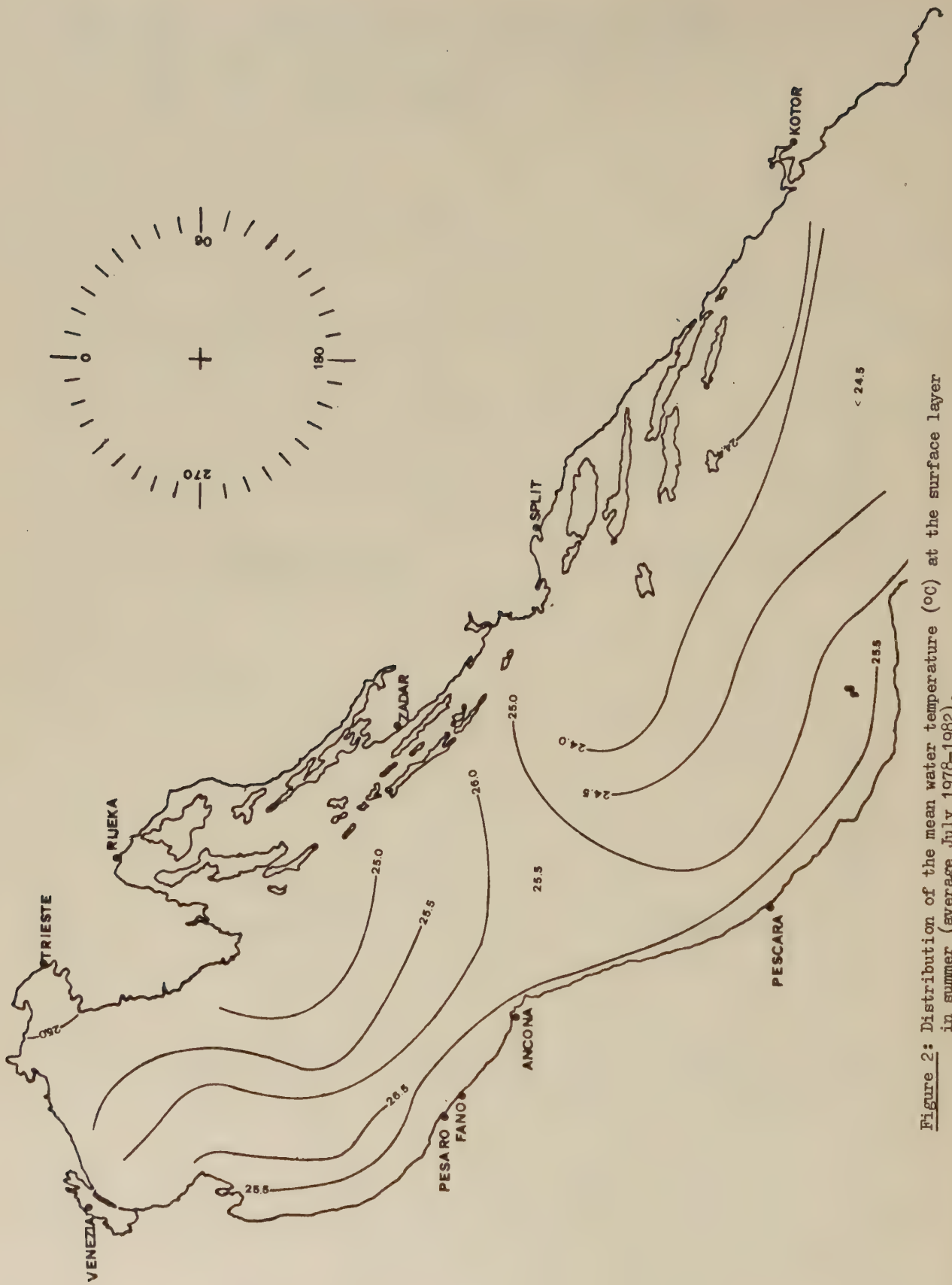


Figure 2: Distribution of the mean water temperature (°C) at the surface layer in summer (average July 1978-1982).

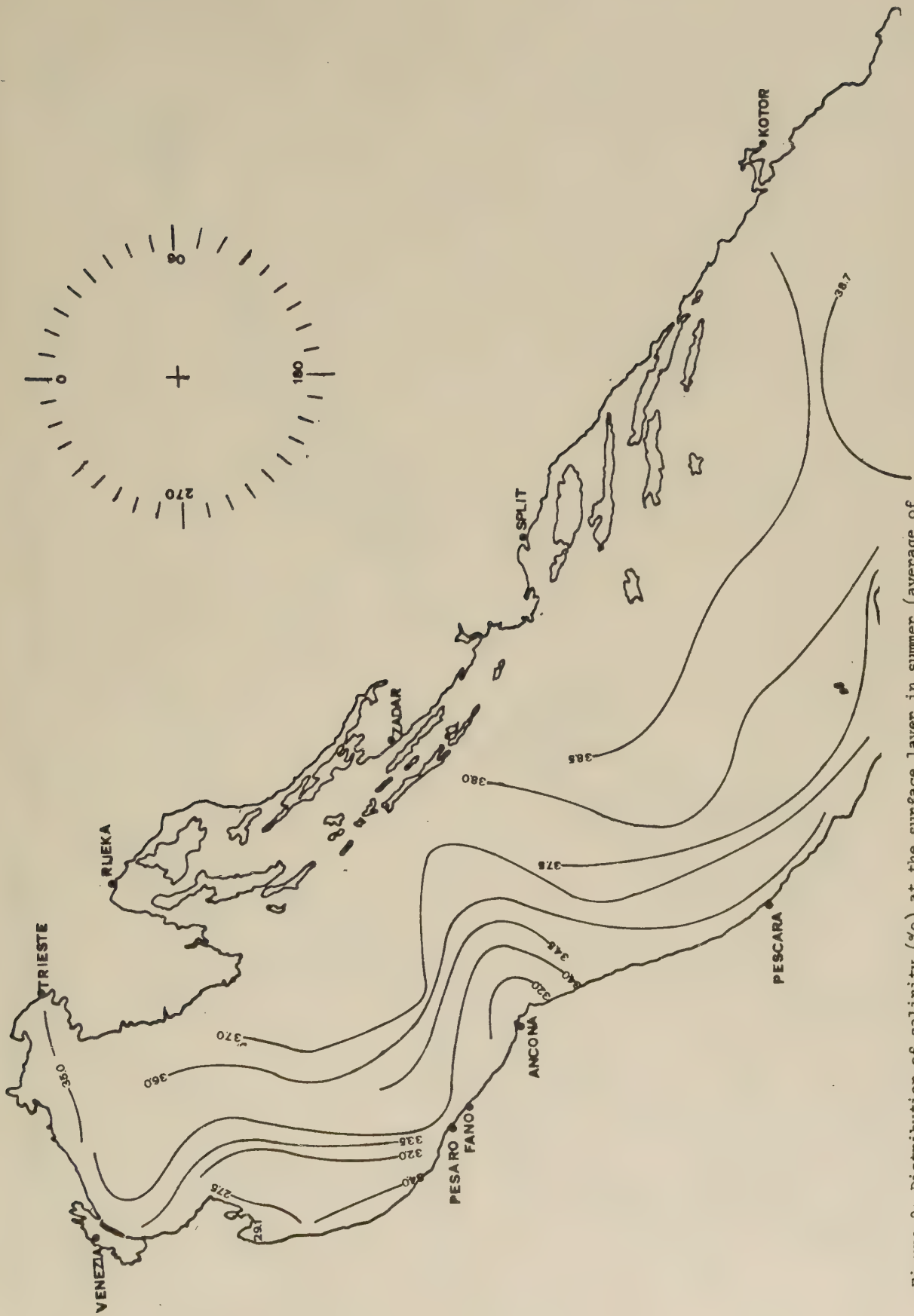


Figure 3: Distribution of salinity (‰) at the surface layer in summer (average of 5 years, July 1978-1982).

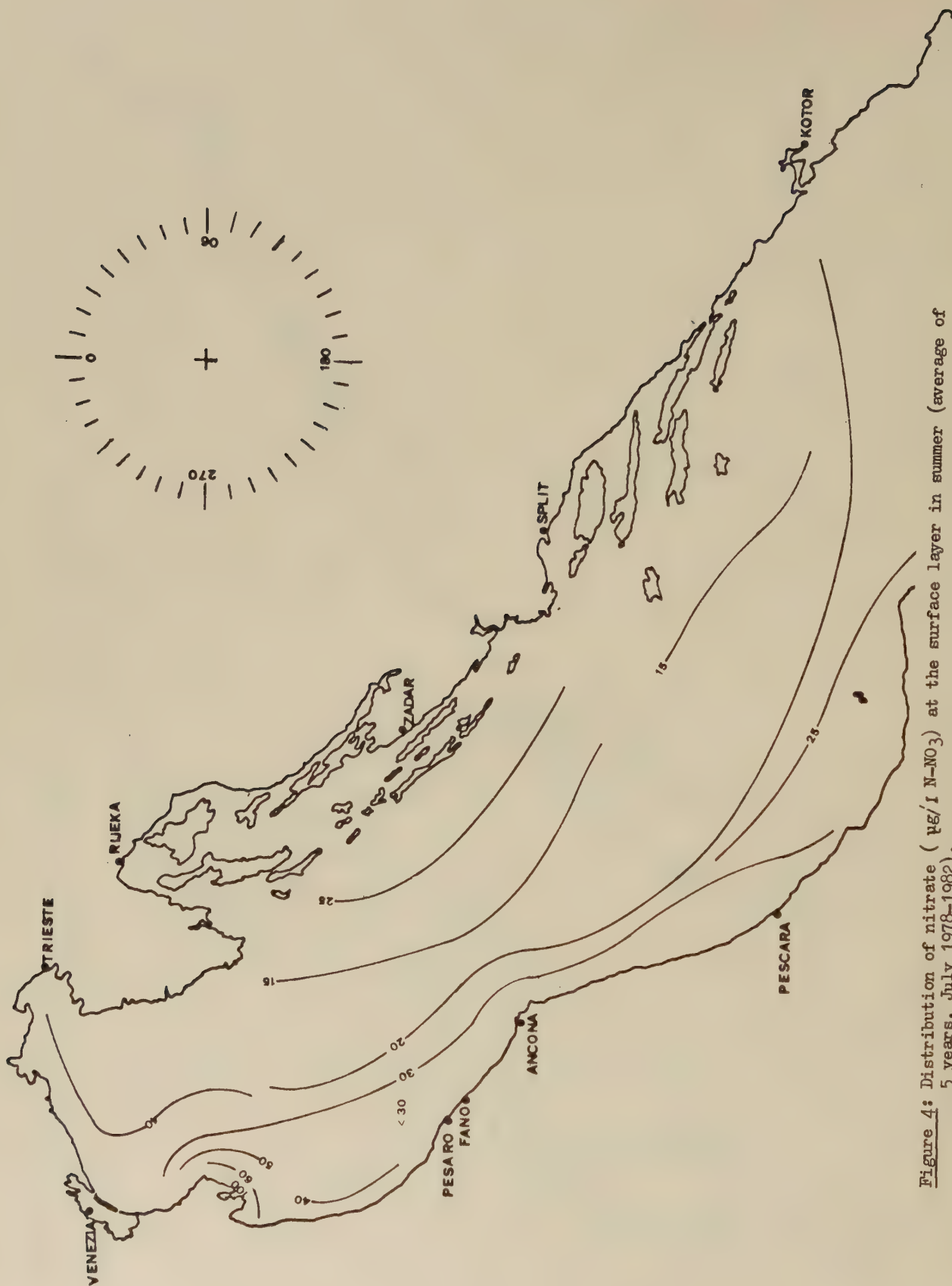


Figure 4: Distribution of nitrate ($\mu\text{g/l N-NO}_3$) at the surface layer in summer (average of 5 years, July 1978-1982).

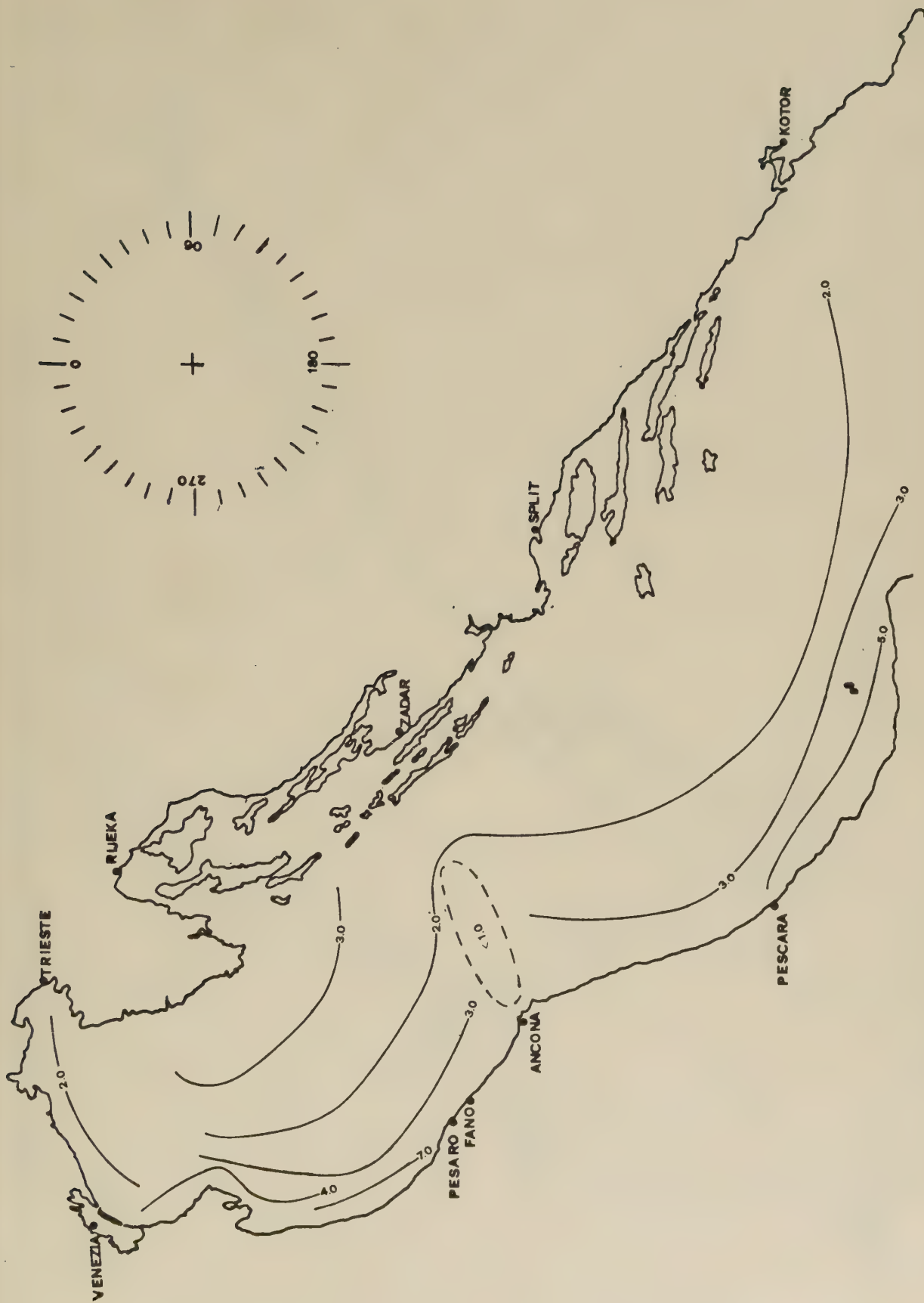


Figure 5: Distribution of phosphate ($\mu\text{g/l P-PO}_4$) at the surface layer in summer (average of 5 years, July 1978-1982).



Figure 6: Distribution of the mean water temperature (°C) at the surface layer in winter (average February 1979-1982).



Figure 7: Distribution of salinity (‰) at the surface layer in winter (average of 4 years, February 1979-1982).



Figure 8. Distribution of nitrate ($\mu\text{g/l N-NO}_3$) at the surface layer in winter (average of 4 years, February 1979-1982)

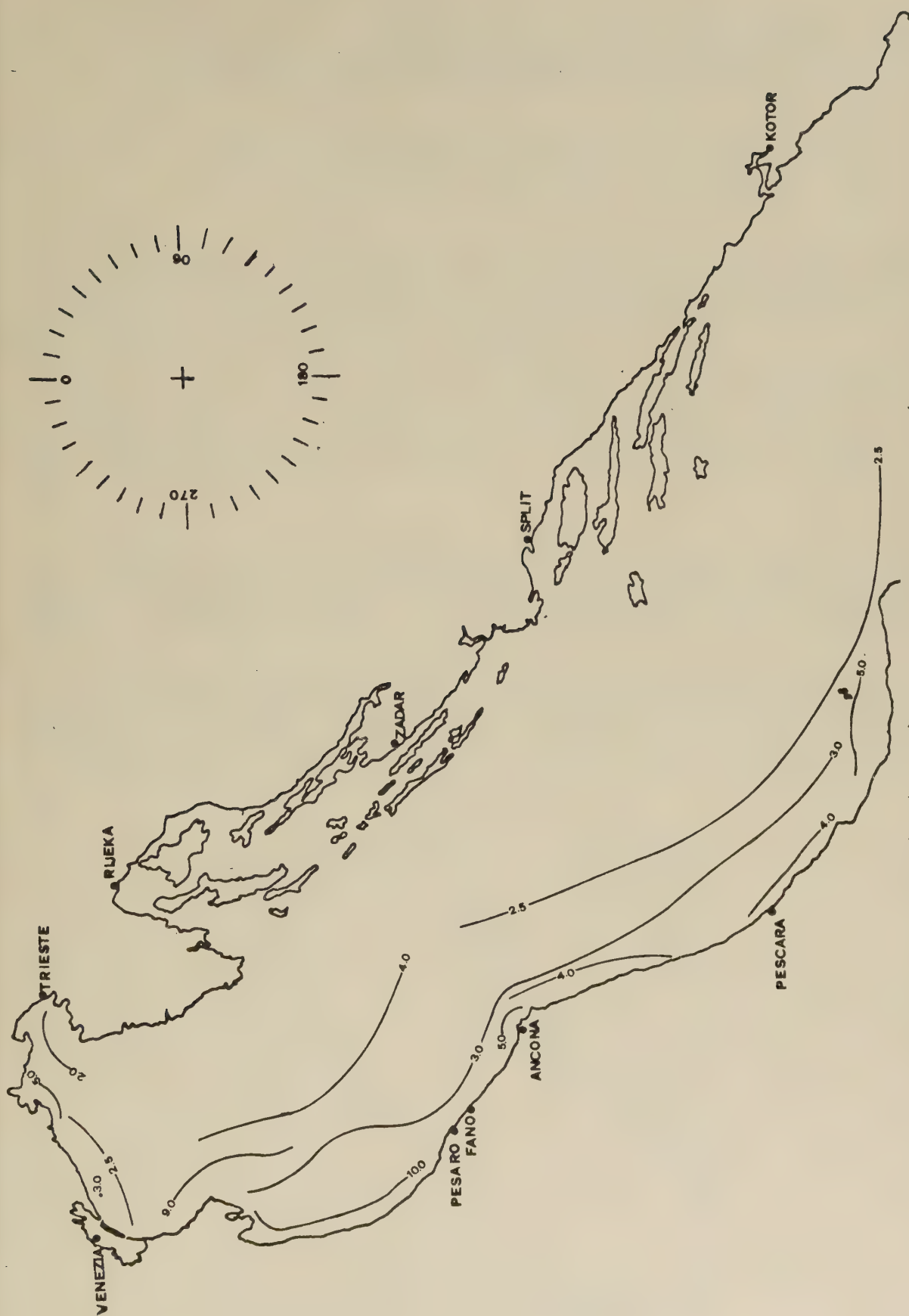


Figure 9: Distribution of phosphate ($\mu\text{g/l P-PO}_4$) at the surface layer in winter (average of 4 years, February 1979-1982).

ANNEXE H / APPENDIX H

Seasonal flow rates of the Italian rivers having outlets in the Northern
and in the Central Adriatic

by

A. Artegiani

Istituto Ricerche sulla Pesca Marittima (C.N.R.) - Ancona, Italy

1. INTRODUCTION

The aim of this note is to present graphically and synthetically the flows of the Italian rivers, from Isonzo to Fortore, having their outlets in the Northern and in the Central Adriatic sea (Figure 1). The data presented in two works of Cavazzoni-Galaverni (1972, 1972a) were used. Considerations on the influence that such flows can have on the physical, chemico-physical and biological processes of the Adriatic sea, will be made.

Many researchers of Italian institutes and those of other countries have dealt and still deal with this complex and very interesting subject. For example Mosetti (1967), making use of hydrological data collected in August 1966, showed that the main cause of the general circulation of the Adriatic, is the strong horizontal gradient, in the density field, present between the Italian and Yugoslav coasts in the Northern Adriatic. This gradient is due to the fresh-water income from the Po and other rivers of the northern Italy.

2. DATA PRESENTATION

The annual mean total flow of all the rivers, from Isonzo to Fortore, computed over the period 1956-65, is 3097 m³/sec. 51 percent of this global flow, i.e. 1585 m³/sec., is due only to the Po river; 34 percent, equal to 1061 m³/sec., is the flow of the rivers from Isonzo to the Po; the remainder, 75 percent, i.e. 455 m³/sec., is due to the rivers that run from the Apennines (from Reno to Fortore). The mean flows of these rivers are very poor and they are torrent-like rivers.

From the above it results that 85 percent of the global flow is due to the rivers that come from the Alps and the Po valley. The data of these rivers will therefore only be presented. Their annual mean flow rate, computed on a period of 46 years (1923-68) is 2522 m³/sec. This flow is 34 percent of all the runoff of the Mediterranean sea (7300 m³/sec., reported by Sverdrup (1942); so, the Adriatic sea, which has a volume of water approximately equal to 1/125 of the entire volume of the Mediterranean sea, receives one third of the continental fresh waters that flow in this basin.

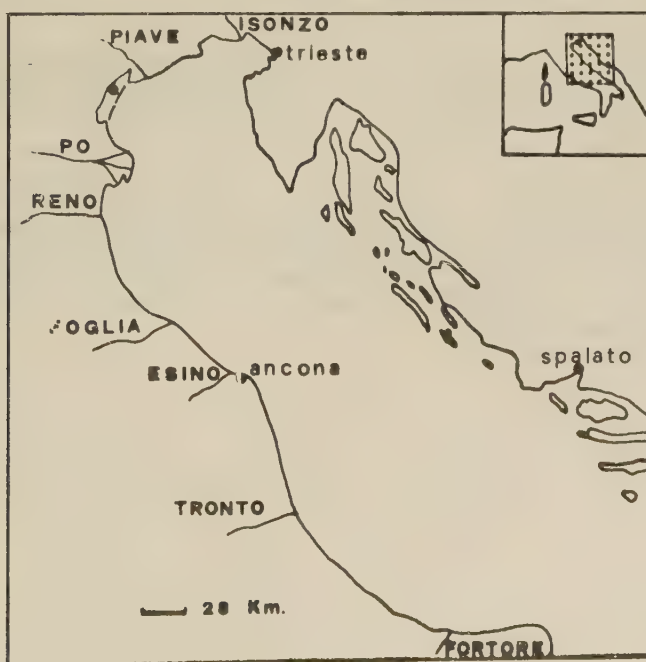


Figure 1: Map of the northern and middle Adriatic.

The annual mean flow rate of the Po is 1481 m³/sec., i.e. 59 percent of the total flow; the remainder, 41 percent, is due to the other rivers from Isonzo to the Adige valley.

The Po is therefore the most important tributary river of the Adriatic sea, but the contribution of the other rivers is not negligible.

In figure 2 the monthly global mean is given. The mean is computed on two periods each of them ten-years long, the first, 1929-38, before the building of the big hydroelectric reservoirs, and the second, 1956-65, after. The two periods are similar as regards meteorological precipitations: 10931 x 10⁶m³ for the period 1928-38 and 11032 x 10⁶m³ for 1956-65.

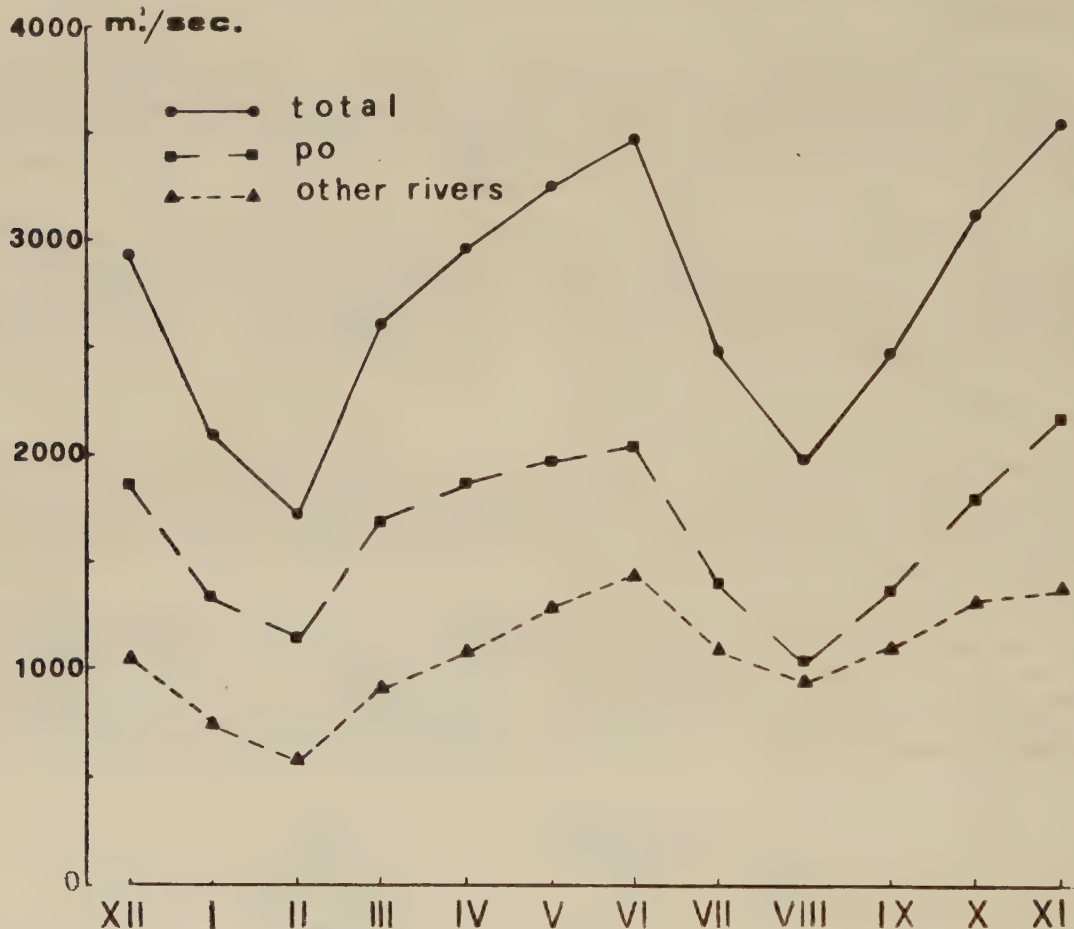


Figure 2: Monthly mean of total (unbroken line), Po (broken line), and other rivers (from Isonzo to Adige valley) (dashed line) flows.

In summer and spring of the second period a little reduction of the flows was recorded whereas an increase was found in winter, related to the hydroelectric reservoirs, which are filled in summer season and partly emptied in winter. The little reduction in the annual flow that Cavazzoni-Galaverni put in evidence in the second period is negligible for the aim of this note: for this reason the two periods have been averaged.

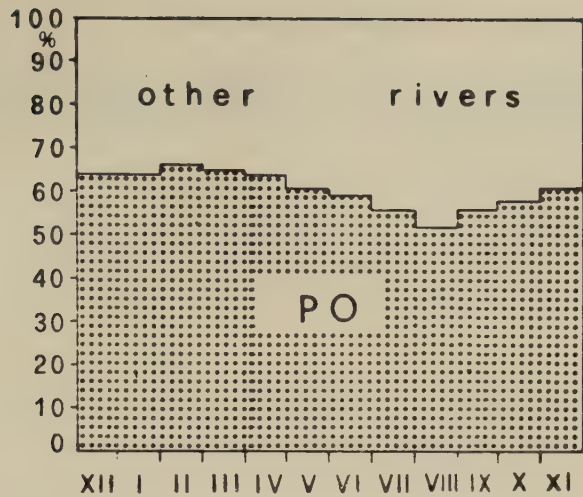


Figure 3: Percentage of total flow due to the Po river, and to the other rivers (from Isonzo to Adige valley).

Two minima are evident in figure 2: the first in winter and the second in summer, clearly related to the droughts seasons.

There are two maxima, the first in spring, generally less strong, due to the melting snows and spring rains; the second in autumn in the period of rains.

Figure 3 shows the percentage of flows due to the Po and the other rivers each month. The percentage due to the Po is always over 50 percent, with a minimum of 52 percent in August and a maximum of 66 percent in February.

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ANNEXE I / APPENDIX I

Distribution of hake (*Merluccius merluccius* L.) Striped Mullet (*Mullus barbatus* L.) and Pandora (*Pagellus erythrinus* L.) in the Adriatic sea

by

S. Jukic* and E. Arneri**

*Institut za oceanografiju i ribarstvo, Split, Yugoslavia

**Laboratorio di Biologia Marina e Pesca, Fano, Italy

1. INTRODUCTION

Observations on the distributions of *Merluccius merluccius*, *Mullus barbatus* and *Pagellus erythrinus* in the Adriatic sea have been collected and put together on the basis of two most extensive expeditions: "Hvar" (1948/49) and "Pipeta" (1982). The data were mostly collected during the trawl surveys over the greatest part of the continental shelf; a standard methodology (bottom trawl nets, vessel speed, duration of the trawl haul) was used for the main goal i.e. assessment of the stock size of edible demersal resources and stock composition.

Though we have been quite aware that between those two expeditions a lot of other data were collected throughout many national programmes in the Adriatic, for the purpose of getting a general picture of the distribution of these populations we have considered only the data of the mentioned expeditions.

2. *Merluccius merluccius* L.

Figure 1 shows the distribution of hake population down to 200 metres depth. It may be seen that the species is distributed over the whole continental shelf except in some small parts of the Northern Adriatic. Except in the Jabuka pit, specimens of 2nd, 3d and 4th year classes dominate in the catch. On the basis of significant numbers of collected data for hake population in the Jabuka pit (Zupanović, 1968; Jukić, 1975) this region should be considered as a main spawning ground where mostly individuals of 0 and 1st year class dominate during the whole year.

Length frequency distribution of the hake population in connection to sea depth (Figure 1.1) show that the smallest individuals occupy sea depth below 150 metres that is the area of Jabuka pit. Within the sea depth range of 100 and 150 metres mostly dominate 3d and 4th year class individuals and in the shallower waters, down to 100 metres 2nd and 3rd year classes.

It has been generally known (Jukić, 1975) that seasonal hake's distribution is closely related to migration of "small pelagic fish" populations (sardine, anchovy), especially as far as the eastern Adriatic coast is considered.

Distribution of relative indices of hake abundance (Table 1) has the maximum value for the sea depth below 200 metres (6.05 kg/hour) in 1948/49 while the depths between 100 and 200 metres have values from 5.35 to 5.62 kg/hour and the smallest up to 100 metres only from 3.52 to 4.29 kg/hour. Similar regularities were found out during the "Pipeta" expedition in 1982. A gross comparison of catch rates during Hvar and Pipeta expeditions is given in Table 1 were lower.

Preliminar evaluation of the state of the hake stock (Figure 1.1) in connection with available statistical data information (total hake catch and estimated fishing effort) shows an MSY of 2.818 to 3.273 tons/year (Alegría-Hernandez, et al. 1983, in press) with corresponding total fishing effort from 54.348 to 62.632 fishing days/year.

3. *Mullus barbatus* L.

With regard to collected data of the two expeditions, Figure 2 gives the general characteristics of striped mullet distribution. It shows that this population has a wide distribution along both Italian and Yugoslav coasts. This species was not found in the central part of the Adriatic, i.e. below 150 metres, where stations are characterized by clay-loamy bottom sediments. Although the distribution is wide, the relative indexes of population abundance decrease when depth increases (Haidar, 1970; Jukić, 1972).

A gross comparison of catch rates between Hvar and Pipeta expeditions is given in Table 1.

4. Pagellus erythrinus L.

Pandora's population distribution is given in Figure 3. According to such data the distribution of this species in the Adriatic sea is limited to 150 metres depth mostly among coastal sandy sediments. The highest values of abundance (catch per unit effort) have been found along the Yugoslav coast as well as oldest and biggest specimens (data are in press), i.e. the fact that might be related to lower level of fishing exploitation of the fishing grounds inside Yugoslav territorial waters and preference of the species to the endofauna of sandy sediments along the eastern Adriatic coast.

Relative indices of population abundance in connection to the sea depth show that this species is mostly concentrated between isobaths 20 and 100 metres, while below this depth only a few specimens could be registered.

A gross comparison of catches rates between Hvar and Pipeta expeditions is given in Table 1.

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Table 1 - Distribution of average indexes of abundance (kg/hour) in relation to sea depth for: Merluccius merluccius, Mullus barbatus and Pagellus erythrinus in the Adriatic sea based on the data of two expeditions: "Hvar" (1948/49) and "Pipeta" (1982) ^{1/}

Sea depth (m)	<u>Merluccius merluccius</u>		<u>Mullus barbatus</u>		<u>Pagellus erythrinus</u>	
	"Hvar" 1948/49	"Pipeta" 1982	"Hvar" 1948/49	"Pipeta" 1982	"Hvar" 1948/49	"Pipeta" 1982
to 50	4.29(22)	1.07(77)	3.72(23)	3.32(101)	3.12(17)	0.63(82)
51 - 100	3.52(62)	2.96(60)	2.77(56)	1.84(54)	2.08(27)	0.74(53)
101 - 150	5.35(79)	2.60(29)	2.64(68)	1.03(22)	1.74(5)	0.41(12)
151 - 200	5.62(67)	2.25(15)	1.86(38)	0.43(10)	-	0.03(6)
above 200	6.05(35)	1.36(11)	1.64(12)	0.60(8)	-	-

Note: () total number of one hour trawl hauls made

^{1/} Because of the higher efficiency of the "Pipeta" trawl (synthetic fiber, higher opening) it is believed that the observed decrease in catch rates underestimates largely the true one.



Figure 1: Distribution of hake (*Merluccius merluccius* L.) populations based on data of the two expeditions "Hvar" (1948/49) and "Pipeta" (1982).

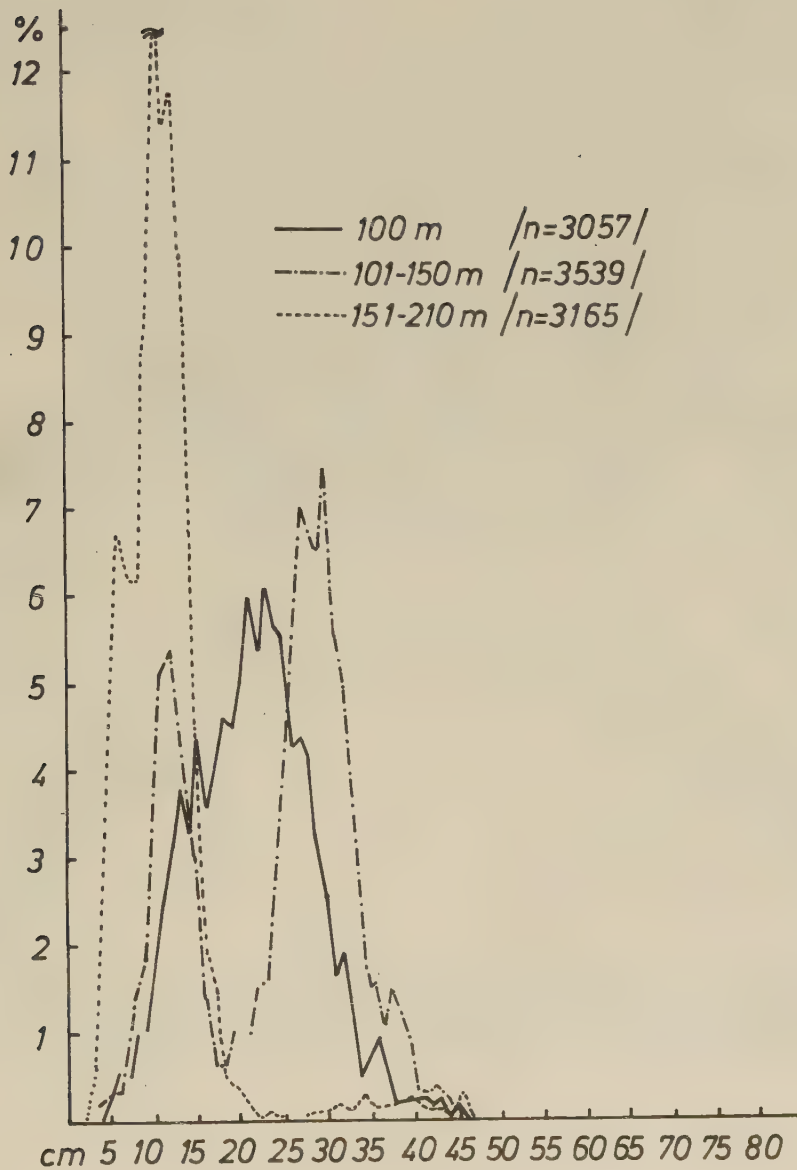


Figure 1.1 - Length frequency distribution of hake (Merluccius merluccius L.) population in the Adriatic sea.



Figure 2: Distribution of the striped mullet (*Mullus barbatus* L.) populations based on data of the two expeditions "Hvar" (1948/49) and "Pipeta" (1982).



Figure 3: Distribution of the pandora (*Pagellus erythrinus* L.) populations based on data of the two expeditions "Hvar" (1948/49) and "Pipeta" (1982).

ANNEXE J / APPENDIX J

Distribution des larves du genre Trachurus en Adriatique

par

A. Guescini

Laboratorio di Biologia Marina e Pesca - Fano, Italie

En Adriatique on pêche trois espèces de chinchards: Trachurus trachurus, Trachurus mediterraneus et Trachurus picturatus, ce dernier seulement en Adriatique sud.

L'étude du matériel planctonique recueilli au cours de plusieurs campagnes sur l'ichthyoplancton en haute et moyenne Adriatique, réalisées par le Laboratoire de Biologie marine et de Pêche de Fano, nous a permis de déterminer la distribution des larves et l'aire de ponte des chinchards.

Les campagnes d'hiver (février-mars) de trois années différentes ont été considérées; on a obtenu des résultats positifs pour des larves de chinchards pour 24 échantillons sur 150, tandis qu'en été on a obtenu 49 échantillons positifs sur 64. En hiver les larves appartiennent à l'espèce mediterraneus.

La figure 1 indique la distribution quantitative des larves de mediterraneus au cours de la campagne d'été 1981 avec 815 larves capturées. La concentration plus forte est localisée dans la partie sud de l'Adriatique centrale, devant Termoli; une absence complète est notée dans le nord de l'Adriatique.

Les conditions du milieu associées à la présence des larves ont varié entre 15,60 et 27,7 0c pour la température et entre 30,5‰ et 38,9‰ pour la salinité.

Les larves de trachurus ont été capturées seulement au cours des campagnes du mois de mars et en très faible quantité. Les larves de cette espèce ne sont pas non plus présentes dans la partie nord de l'Adriatique.

Pour ces deux espèces, la saison de ponte est différente; pour trachurus, elle pourrait commencer en février-mars et se terminer en juin; pour mediterraneus, il semble que la ponte commence en juin pour se terminer à la fin de l'été.

L'aire de ponte pour les deux espèces de chinchard semble exclure le nord Adriatique.

On n'a pas trouvé de larves de picturatus, qui a probablement une aire de ponte située dans une zone plus au sud que celle étudiée.

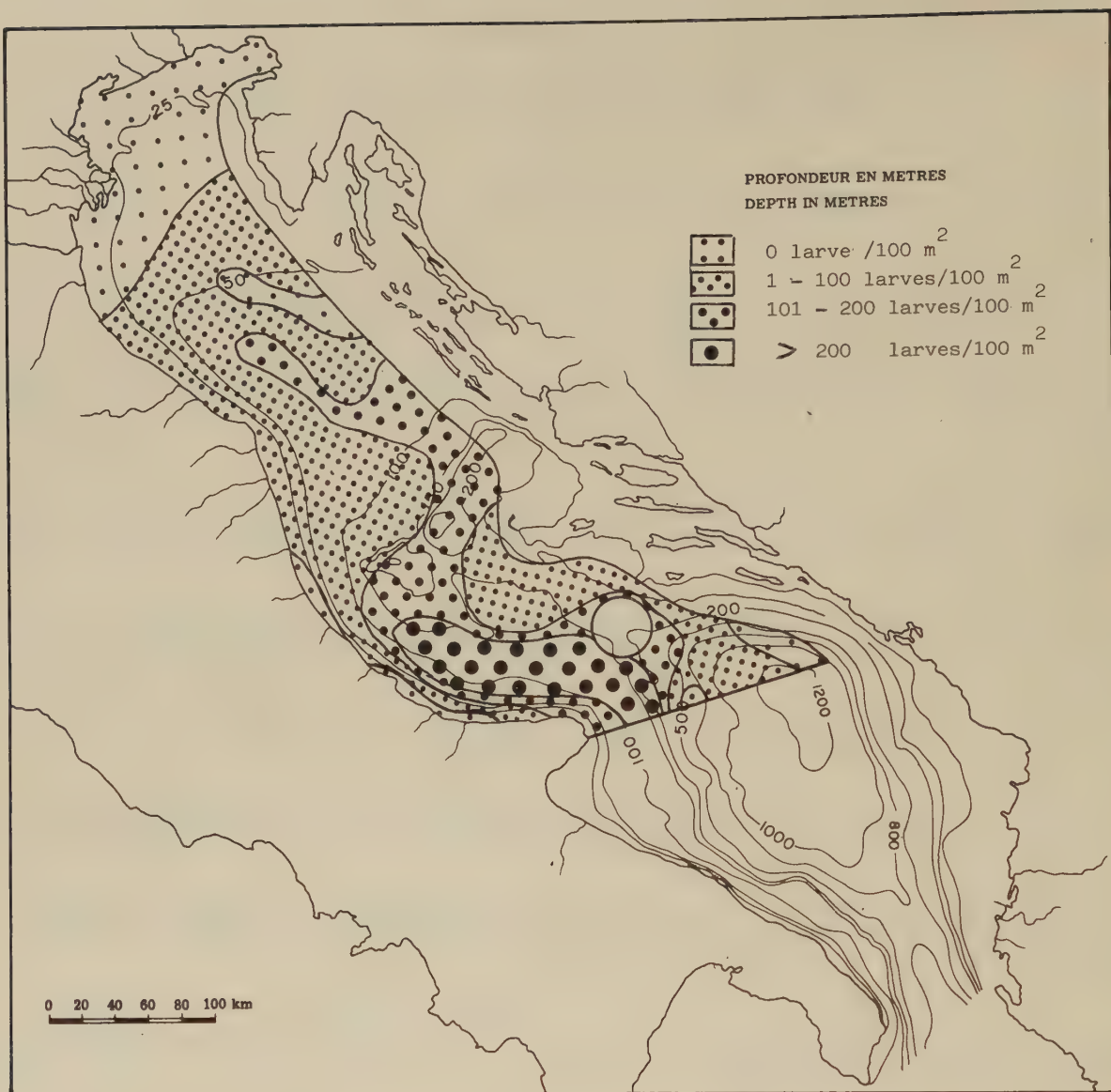


Figure 1 - Distribution des larves de Trachurus mediterraneus en juillet 1981.

ANNEXE K / APPENDIX K

Horizontal and vertical distribution of benthos Selachia (Pleurotremata, Hypotremata)
in the Adriatic

by

Ivan Jardaš

Institute of Oceanography and Fishery - Split, Yugoslavia

1. INTRODUCTION

Up to now 52 species of cartilaginous fish have been registered in the Adriatic: 28 Pleurotremata spp., 23 Hypotremata spp., and 1 Chimaerea sp. The range of their distribution and population numerosness of individual species vary; most often these are rare or even very rare fishes, sometimes with a limited distribution range; only 10 species are distributed widely with numerous populations. Among these some are of economic importance (Scyliorhinus canicula, S. stellaris, Mustelus spp., Squalus spp., Raja clavata, Raja miraletus, Dasyatis pastinaca, Myliobatis aquila). More numerous cartilaginous fish populations exist on the sea bottoms which are not enough exploited by trawling, and some single species or several species together (e.g. Scyliorhinus canicula, Myliobatis aquila, Raja clavata) cover up to 50 per cent of the trawl catches in weight.

In this paper data are collected on the distribution of 32 species of benthic Pleurotremata and Hypotremata. More complete data on the horizontal distribution of the benthic cartilaginous fish are available for the eastern Adriatic coast and open sea, and for the vertical distribution mainly for the continental shelf region. The data available for the North Adriatic, the western coast and the deep South Adriatic depression were inadequate.

2. DATA USED

Data collected after 1948 were used for drawing up charts of the horizontal distribution and for the basic ecologic factors of the environment on which this distribution depends (depth and granulometric composition of the bottom sediments).

For the largest part of the continental self of the open Adriatic the data used were on the composition of the benthic fish settlements, depth and texture of the bottom sediments collected during the expedition "HVAR" 1948-1949 (Morović, 1951; Karlovac, 1956, 1959), on the structure of the benthic fish settlements in the region of the continental shelf of the open Central Adriatic (Jukić, 1975), a part of the open North and Central Adriatic (Županović and Grubisić, 1958; Piccinetti and Jukić, 1973; Jukić, 1976; Jukić and Piccinetti, 1981; G. Piccinetti and G. Piccinetti Manfrin, 1981), the open South Adriatic (Kirinčić, and Lepetić, 1955; Merker and Ninčić, 1973), and the Bay of Kotor (Lepetić, 1965).

Also unpublished data on the composition of the benthic fish settlements, depth and bottom sediment texture of the open sea and channel regions of the North, Central and South Adriatic collected during the above period were used.

The data on the texture of the bottom sediments and sea depths of the channel region had been extracted from some earlier already quoted works (Crnković, 1970; Županović, 1961; Lepetić, 1965), and from Alfirević (1964).

The types of the sea sediments, which had been used before and in this work as well, are given according to Gračanin (1947). They are based on the contents percentage of the so-called coarse mechanical elements - the sediment particles classified according to the categories from I to IV (under 0.01 mm to 2 mm):

Texture designation	Particle composition %			NOTE
	I cat. < 0.01 mm	II cat. 0.01-0.05 mm	III cat. IV cat. 0.05-0.2 mm	
<u>Clay</u>	> 60	-	-	
Loamy clay	50-60	≥ 20	-	
Sandy clay	50-60	< 20	-	
Clay loam	40-50	-	}	
<u>Loam</u>	25-40	> 30	} < 50	
Clay sandy loam	25-40	< 30	}	
Sandy loam	< 25	-	}	
Clay sand	> 25	-	}	
Loamy sand	-	> 25 +	}	
Loamy clay sand	< 25 +	(I II)	) > 50	+(I + II) > 10
Clay loamy sand	(I<II)	< 25 ⁺	)	
<u>Sand</u>	(I + II) < 10		)	

In this way 12 types of sea bottom sediments were obtained of which sand, clay sand, loam sand, loamy clay sand, clay loamy sand belong to sandy, while all the other types of the sediments belong to muddy bottoms (e.g. loam, clay, clay loam, loamy clay, sandy clay, etc.).

3. DISTRIBUTION OF SPECIES

3.1 Pleurotremata

3.1.1 Scyliorhinus canicula (L.) Figure 1.

Distribution: It is generally distributed all through the continental shelf and part of the continental slope, except in the region of the Jabuka depression and part of the Palagruža bank over which the water masses of the Jabuka depression with specific ecologic characteristics shift into the South Adriatic depression. The ecologic characteristics of these waters are the main reason for avoiding these regions (Jardas, 1979a). This species does not inhabit the deeper parts of the South Adriatic depression either.

Substratum: It is widespread on all kinds of bottoms, but it prefers the bottoms with coarser particles of sediments (Jardas, 1979a).

Depth: It lives on depths from 5/6 m down to about 400 m, but the most numerous population lives on the bottoms from 100 to 200 m (Jardas, 1979). According to the data collected by the "HVAR" expedition at the depths from 30 to 100 m the trawl catches had 40.3 samples on the average by haul, from 100 to 200 m 43.8, from 200 to 300 m 35.7, and from 300 to 400 m 11.5. The most numerous population in the Adriatic was registered in the outer side of Dugi Otok, and in the north-west of the island of Vis. It is not frequently found along the western coast of the Adriatic.

3.1.2 Scyliorhinus stellaris (L.) Figure 2.

Distribution: It inhabits the region of the shelf exclusively. It keeps to the channels and open sea regions. The newest data show that it is rare in the western half of the Adriatic.

Substratum: It lives on different bottoms (sandy and muddy) but it prefers the bottoms with coarser structure of the sediments - sandy or muddy bottoms with a greater presence of sandy fractions. Županović (1961) found this species as the preferential one on the sandy bottoms of the Central Adriatic channels, and he thinks that the edaphic factors play an important role in its distribution.

Depth: It inhabits the bottoms from the coast to the depths of about 190 m; however, it is most frequent on the bottoms down to a depth of 100 m.

3.1.3 Galeus melastomus Raf. Figure 2.

Distribution: It inhabits the region of the bank and continental slope of the South Adriatic exclusively.

Substratum: It inhabits the muddy (loamy, clay) bottoms exclusively.

Depth: It lives exclusively on the regions deeper than ca 200 m. A more numerous population was registered below the depth of 300 m, and after Kirinčić and Lepetić (1955), it is the most numerous at the depths of more than 800 m (the maximum was from 1,000 to 1,200 m depth).

3.1.4 Galeorhinus galeus (L.) Figure 3.

Distribution: It inhabits the regions of the continental shelf and a part of the continental slope of the central and southern part of the Adriatic. Recently it was recorded only in the eastern half of the Adriatic. It inhabits the channels and the open sea.

Substratum: It lives on different kinds of bottoms, but it definitely prefers the bottoms with a finer structure of sediments (clay, loam or mixed bottoms).

Depth: It was caught on the bottoms at the depth of 20 to 700 m, but more often at depths less than 200 m.

3.1.5 Mustelus mustelus (L.) Figure 3.

Distribution: Recently it was registered only in the catches along the continental shelf of the eastern coast of the Adriatic. It was caught both in the channels and in the open sea. It is more numerous in the channels.

Substratum: It is widespread on various kinds of bottoms but it clearly prefers muddy bottoms (loam, clay and mixed bottoms). According to the data collected by the "HVAR" expedition (Karlovac, 1978) 87,5 per cent of samples were caught on muddy bottoms, and only 12,5 per cent on sandy bottoms especially on those with a greater proportion of clay or loamy components.

Depth: It inhabits the bottoms at depths from 9 to 200 m. Its preference to some definite depths with this range has not been noticed.

3.1.6 Mustelus asterias Cloq. Figure 4.

Distribution: It is widespread diffusively in all the Adriatic, but especially in its eastern half and particularly in the channels.

Substratum: It is widespread on various kinds of bottoms with a strongly expressed preference for muddy bottoms (clay, loam or mixed bottoms). According to the data collected by the "HVAR" expedition (Karlovac, 1978) 70 per cent were caught on muddy bottoms, and 30 per cent on sandy bottoms with a greater percentage of clay or loamy component.

Depth: It inhabits the regions of the continental shelf and a part of the slope down to the depth of 400 (440) m. It is more frequent between 100 and 200 m.

Note: It is somewhat more numerous than its related species M. mustelus.

3.1.7 Oxynotus centrina (L.) Figure 5.

Distribution: It is generally rare. It is diffusively distributed. According to recent data it inhabits the eastern half of the Adriatic, the channels and the open sea.

Substratum: It prefers fine sandy bottoms, but it is also found on muddy bottoms (clay and loamy bottoms).

Depth: It inhabits the region of the continental shelf between depths of about 36 to 175 m.

3.1.8 Squalus acanthias L. Figure 6.

Distribution: It is distributed especially in the northern and central parts of the eastern half of the Adriatic. It is more numerous in the channels.

Substratum: According to the data from the "HVAR" expedition it was caught on different bottoms; the greatest number of samples, however, was registered on the loamy clay sand (26,19 per cent) and clay loam (23,81 per cent) (Karlovac, 1976).

Depth: It lives on the continental shelf and a part of the slope between the depths of 10 and 400 m; it is found exceptionally down to 950 m. During the "HVAR" expedition the greatest number of samples were caught at the intermediate depths from 59 to 200 m (87,23 per cent) (Karlovac, 1976), which can be considered preferential.

3.1.9 Squalus blainvillei (Risso). Figure 7.

Distribution: It inhabits exclusively the central and southern parts of the Adriatic, namely the region South of the Jabuka pit. Recently it was caught mainly in the eastern half of the Adriatic.

Substratum: It was caught on different bottoms, but it prefers soft bottoms of clay loamy composition of sediments (Karlovac, 1976).

Depth: It inhabits the region of the continental shelf and a part of the slope at the depth of between 30 and ca 600 m. It is more numerous, however, down to ca 400 m (Kirinčić and Lepetić, 1955), and within this range it seems to prefer the depths between 100 and 200 m (Karlovac, 1976).

Note: It is more numerous than its relative species S. acanthias.

3.1.10 Centrophorus granulosus (Sch.). Figure 6.

Distribution: It is distributed exclusively in the region of the continental slope of the South Adriatic depression.

Substratum and depth: According to the present data (the "HVAR" expedition, Kirinčić and Lepetić, 1955) it inhabits the muddy (clay) bottoms and the depths beyond 440 m. After Kirinčić and Lepetić (1955), the greatest number of samples were caught at the depths of 600 and 800 m. The females were caught down to ca 700 m (maximum at ca 500 and 600 m) while the males from 600 m downwards (maximum at 800 m).

3.1.11 Etmopterus spinax (L.) Figure 6.

Distribution: It is distributed exclusively in the region of the continental slope of the South Adriatic depression. It is rather rare.

Substratum and depth: In the South Adriatic depression it lives on clay bottoms deeper than 650 m. The highest population number was recorded at depths from 1,000 to 1,200 m (Kirinčić and Lepetić, 1955).

3.1.12 Scymnorhinus lichia (Bonn.). Figure 7.

Distribution: It inhabits exclusively the regions of the continental slope of the South Adriatic depression. It is rare.

Substratum and depth: Up to now it was caught in the South Adriatic at depths from 500 to 700 m on clay sediments. (Kirinčić and Lepetić, 1955).

3.1.13 Squatina squatina (L.). Figure 6.

Distribution: It spreads mainly over the region of the continental shelf. Lately it was caught only in the eastern half of the Adriatic and in its northern and southern parts (south from the Jabuka Pit). It is more frequent in the open sea.

Substratum: It is distributed on sandy and muddy bottoms but more frequently on bottoms with a finer structure of sediments. (Clay and loam bottoms).

Depth: It inhabits at depths between 50 and 300 m, but more often at a depth less than 200 m.

Among other species of benthic or benthic-pelagic species of Pleurotremata of the Adriatic we dispose of available data (however poor) on the distribution of the species Heptranchias perlo (Bonn.). Until now this rather rare but widespread species (possibly circumglobal in the warm seas (Boeseman, 1979), were caught (juvenile samples) only on the continental slope of the South Adriatic depression during the "HVAR" expedition (stations: 136, 163) at depths from 207 to 377 m and on the sandy loamy and clay loamy sediments of the bottom (Karlovac, 1959).

3.2 Hypotremata

3.2.1 Torpedo marmorata Risso. Figure 8.

Distribution: It is widespread on the continental shelf of the eastern part of the Adriatic, in the channels and in the open sea. It has not been caught recently in the western half.

Substratum: It is distributed on the sandy, muddy and mixed bottoms with rather coarser particles of sediments (clay sand, loamy sand, clay loamy sand, loamy clay sand, and the like).

Depth: It is distributed at depths from the coast down to 200 m, but more often at less than 100 m.

The other species of genus *Torpedo*, i.e. *T. (Torpedo) torpedo* (L.) and *T. (Tetronarce) nobiliana* Bonap., both widespread in the eastern Atlantic and in the Mediterranean (Krefft and Stehmann, 1979), were caught recently only in the eastern half of the southern part of the Adriatic; the former in the region of the mouth of the river Bojana at depths between 10 and 40 (50) m, but more so down to 20 (30) m, and the latter in the open sea region and at the mouth of the river Bojana (Merker and Ninčić, 1973).

3.2.2 *Raja miraletus* L. Figure 9.

Distribution: It is widespread all through the Adriatic except in the region of the Jabuka pit, a part of the Palagruža bank, and in the deeper part of the South Adriatic depression. Recently it is more frequent in the eastern half of the Central and South Adriatic. It is widespread in the channels and in the open sea.

Substratum: The distribution of this species, according to the present available data, depends greatly on the kind of the bottom sediment. In the channel region and in that of the open sea of the Central Adriatic it was caught almost exclusively on sandy or sandy shelly bottoms (Županović, 1961; Jardas, 1973). It is rarely found on muddy bottoms (clay loam, loamy clay, loam, clay).

Depth: It lives on the bottoms at depths down to 200 m, but it prefers the depths more than 100 m. So, for example, the mean catch per trawl haul was from 0.8, to the depth of 100 m, and 1.7 samples at the depths from 100 to 200 m (Jardas; 1979a).

3.2.3 *Raja asterias* Delar. Figure 10.

Distribution: It is distributed almost exclusively in the southern part of the Adriatic. In the Central Adriatic it was registered only along the western coast in the Ancona region.

Substratum: It was found on muddy bottoms (clay, loam and mixed bottoms).

Depth: It is distributed at depths from 10 to 400 (500) m, but it is more frequent in the coastal zone at depths less than 100 m.

3.2.4 *Raja clavata* L. Figure 11.

Distribution: It is widespread all over the continental shelf and a part of the continental slope, but more in the eastern than in the western half of the Adriatic. It inhabits the channels and the open sea.

Substratum: It is distributed on sandy, muddy and mixed bottoms; however, it prefers the bottoms with a more prominent sand component (Županović, 1961; Jardas, 1973).

Depth: It inhabits the bottoms somewhat beyond the depth of 400 m, but its more numerous population was found at depths from 100 to 300 m. So, for example, on the bottoms down to 100 m the mean trawl catch was 4, from 100 to 200 m 8.5, from 200 to 300 m 8.3, and below 300 m 3.8 samples (Jardas, 1979a).

Note: The most frequent species of the *Raja* genus in the Adriatic. Commercially significant.

3.2.5 *Raja montagui* Fowl. Figure 9.

Distribution: According to the newest data, it is diffusely distributed on the continental shelf and slope mainly of the central and southern parts and almost exclusively in the eastern half of the Adriatic. In general, it is caught in the open sea.

Substratum: It is caught on loamy, clay and sandy bottoms (loam, clay, sand, clay loam, clay sand).

Depth: It is registered on bottoms at depths between 40 and 700 m, but most frequently to depths of 100 m.

3.2.6 *Raja batis* L. Figure 10.

Distribution: It seems to be distributed diffusely in the whole Adriatic in the channels and open sea regions, and more in the eastern than in the western half of the Adriatic. It is relatively rare.

Substratum: It is evenly distributed on muddy and sandy bottoms.

Depth: It varies between 65 and 370 m; however, it is more frequently caught on the bottoms of the continental shelf down to the depth of 200 m.

3.2.7 Raja oxyrinchus L. Figure 12.

Distribution: It is diffusely distributed all through the Adriatic, however, less frequently caught in the northern part and in its western half. It is relatively rare.

Substratum: It is distributed on the clay, loamy, and sandy bottoms, however, it seems to prefer tougher (muddy) bottoms with more expressed loamy and clay components.

Depth: It was caught at depths between 50 and 1,100 (1,200) m thus showing its eurybathic character, still preferring the depths beyond 100 (200) m.

3.2.8 Raja (Leucoraja) circularis Couch. Figure 10.

Distribution: It was found diffusely distributed exclusively in the region of the bank and the continental slope of the South Adriatic depression. A rare species.

Substratum: It is distributed on fine sandy and muddy bottoms.

Depth: It was caught on bottoms between ca 180 m (the "HVAR" expedition) and 1,100 (1,200) m (Kirinčić and Lepetić, 1955), but more often at depths beyond ca 300 m.

3.2.9 Raja alba Lac Figure 10.

Distribution: It is diffusely distributed all through the Adriatic on the continental shelf and the slope, but mainly in the open sea. Recently it was found almost exclusively in the eastern half of the Adriatic.

Substratum: It is distributed mainly on entirely sandy or mixed muddy sandy bottoms. It was seldom found on completely muddy bottoms (loam).

Depth: It was caught on bottoms between the depths of 30 to 186 m (the "HVAR" expedition), but mainly on the bottoms at less than 100 m.

3.2.10 Raja radula Delar. Figure 12.

Distribution: Recently it was registered only on the continental shelf of the open Central Adriatic, mainly in its eastern half.

Substratum: It was found equally on sandy (sand, loamy sand, loamy clay sand) and muddy bottoms (clay, loam, clay loam, loamy clay).

Depth: It was caught on the bottoms at the depths between 60 and 188 m; however, it prefers the depths below 100 m.

In the Adriatic, in addition to this species of the Raja genus, also occur species R. polystigma Regan and R. undulata Lac., and, according to Tortonese (1956), also R. (Leucoraja) fulonica L. When mentioning this species he briefly stated "raro in Adriatico". Soljan (1975), however, did not state this last species in the Adriatic, so its presence in the Adriatic is doubtful; in fact during the period after 1948, for which the data are quoted here, not a single sample was registered. R. polystigma is a relatively rare Mediterranean endemic species (Stehmann, 1979), which, in the above mentioned period, was registered only in the Central Adriatic (4 samples) south of Rogoznica at the depth between 118 and 128 m on loamy sandy bottom (Županović and Grubišić, 1958). Another species (R. undulata), which is more widely distributed in the eastern Atlantic and the western Mediterranean (Stehmann, 1979), was not caught at that period in the Adriatic.

3.2.11 Dasystis pestinaca (L.), Figure 13.

Distribution: During the period of observation it was caught diffusely on the continental shelf of the central and southern parts of the eastern half of the Adriatic. It is distributed in the channels and the open sea. It was not registered in the catches from the North Adriatic, from along the western coast, and from the region of the Jabuka pit.

Substratum: It inhabits sandy, muddy and mixed bottoms; it, however, prefers the bottoms with clay and loamy sediments (muddy bottoms).

Depth: From 13 to 150 m, but mainly less than 100 m.

3.2.12 Dasyatis centroura (Mitch.) Figure 13.

Distribution: The available data show that it is distributed on the continental shelf of the central and southern parts of the eastern half of the Adriatic. It is distributed in the channels and the open sea.

Substratum: It inhabits sandy and muddy bottoms.

Depth: It was caught at depths between 30 and 115 m.

3.2.13 Myliobatis aquila (L.). Figure 13.

Distribution: It is diffusely distributed on the continental shelf along the whole eastern half of the Adriatic in the channels and in the open sea. Lately it was not caught in the western half of the Adriatic.

Substratum: It inhabits sandy, muddy and mixed bottoms, but it prefers tougher muddy bottoms (clay and loamy bottoms).

Depth: It is distributed on the bottoms at the depths from the coast (9 m) to 95 m, but most often down to 50 m.

Note: Semipelagic species. At some places it is caught by trawl in great numbers.

3.2.14 Pteromylopus bovinus (Geoffr.). Figure 13.

Distribution: The data about its distribution in the Adriatic are still very poor. During the period of observation it was twice registered in the catches: in the Bay of Kastela (44 samples) on the loamy bottom at the depth of 38 m (the "HVAR" expedition) and in the Bay of Kotor (2 samples) on the clay bottom at the depth of 31 m (Lepetić, 1965).

4. CONCLUSION

Regarding the depth, the greater part of the Adriatic benthic Selachia inhabit the bottoms of the continental shelf, and a smaller part of the continental slope (the bathyal zone) down to the lowest depths of the Adriatic (1,233 m - Tešić, 1963). The bathyal species belong mainly to the Pleurotremata group (Galeus, Centrophorus, Etmopterus, Scymnorhinus), while Raja (Leucoraja) circularis belongs to Hypotremata. The species Raja oxyrinchus shows the eurybathic character of distribution. A great number of species inhabit partly the continental shelf and partly the upper part of the continental slope (Scyliorhinus canicula, Galeorhinus galeus, Mustelus asterias, the species of the genus Squalus and some species of the Raja genus).

Only the species that inhabit the continental shelf are commercially significant in the Adriatic trawling.

It is remarkable that lately a great number of the benthic species Selachia have not been recorded in the catches in the western half of the Adriatic. The reason cannot be attributed to abiotic factors of the environment, but to the negative result of more intensive fishery interventions. It is, namely, well known that the cartilaginous fish, due to a relatively slow reproduction, are very susceptible to the intensive exploitation, so that the long lasting and intensive fishing effects rapidly their number and make them disappear. Intensive fishery does not reflect itself drastically on the fish with a shorter life cycle and greater reproductive capacity. Therefore the number of the population and the distribution of the cartilaginous fish (along with some other morphometric characteristics) can be taken as a good indicator for the fishing intensity in particular regions.

It can be concluded that the noticeable "gaps" in the western half of the Adriatic result from intensive fishing.

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ANNEX I
Vertical distribution of the Adriatic benthic Selachia

Species	0	100	200	300	400	500	600	700	800	900	1000	1100	1200
<i>Heptanchias perlo</i> (Bonn.)													
<i>Scyliorhinus canicula</i> (L.)													
<i>Scyliorhinus stellaris</i> (L.)													
<i>Galeus melastomus</i> Raf.													
<i>Galeorhinus galeus</i> (L.)													
<i>Mustelus mustelus</i> (L.)													
<i>Mustelus asterias</i> Cloq.													
<i>Oxymotus centrina</i> (L.)													
<i>Squalus acanthias</i> L.													
<i>Squalus blainvillei</i> (Risso)													
<i>Centrophorus granulosus</i> (Schn.)													
<i>Etmopterus spinax</i> (L.)													
<i>Scyrnorhinus lichia</i> (Bonn.)													
<i>Squatina squatina</i> (L.)													
<i>Torpedo</i> (Torpedo) <i>marmorata</i> Risso													
<i>Torpedo</i> (Tetronarce) <i>nobiliana</i> Bonap.													
<i>Raja</i> (Raja) <i>miraletus</i> L.													
<i>Raja</i> (Raja) <i>asterias</i> Delar.													
<i>Raja</i> (Raja) <i>clavata</i> L.													
<i>Raja</i> (Raja) <i>montagui</i> Fowl.													
<i>Raja</i> (Dipturus) <i>batis</i> L.													
<i>Raja</i> (Dipturus) <i>oxyrinchus</i> L.													
<i>Raja</i> (Leucoraja) <i>circularis</i> Couch.													
<i>Raja</i> (Rostroraja) <i>alba</i> Lac.													
<i>Raja</i> <i>radula</i> Delar.													
<i>Dasyatis pastinaca</i> (L.)													
<i>Dasyatis centroura</i> (Mitch.)													
<i>Myliobatis aquila</i> (L.)													
% of species	78.6	67.9	50.0	46.4	28.6	28.6	28.6	17.8	17.8	17.8	17.8	17.8	17.8

Fig. 1: *SCYLIONIDUS CANICOLA* (L.)

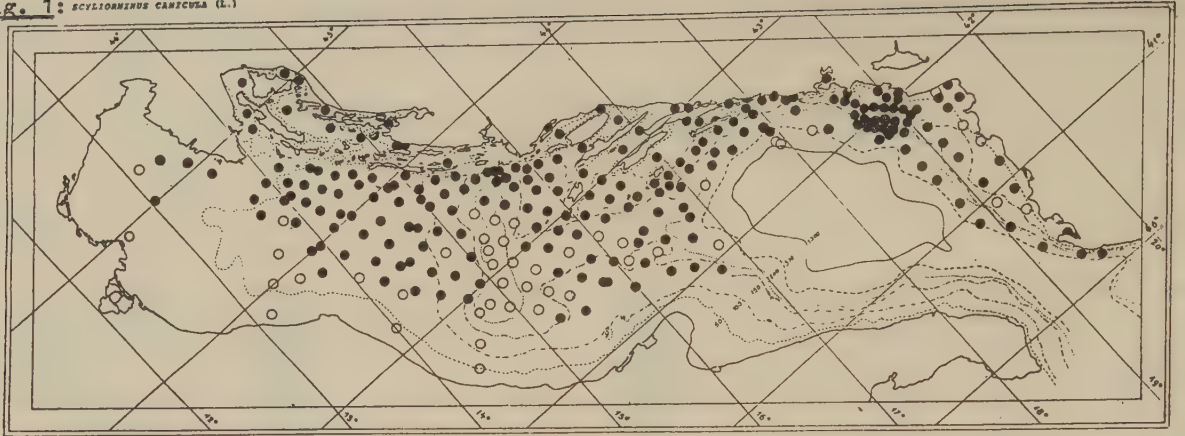


Fig. 2: ● *SCYLIONIDUS STELLARIS* (L.) ⊙ *GALUS MELASTOMUS* RAZ.

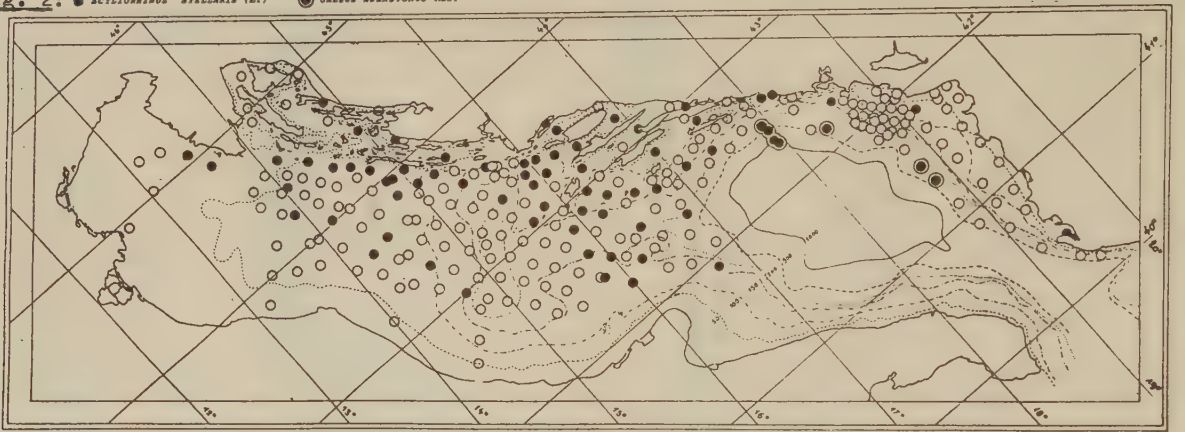


Fig. 3: ● *MUSTELUS MUSTELUS* (L.) ⊕ *GALORINUS GALUS* (L.)

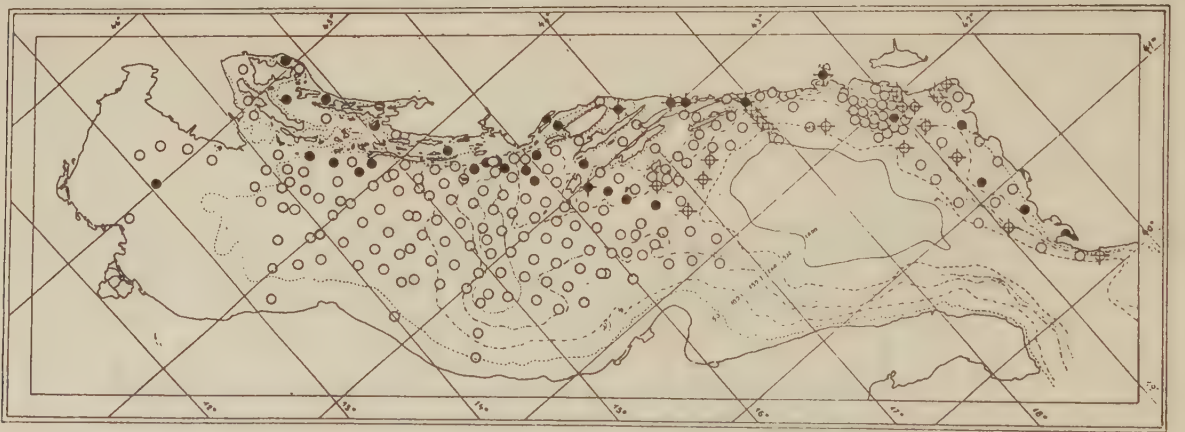


Fig. 4: *USTELUS ASTERIAS* Cloq.

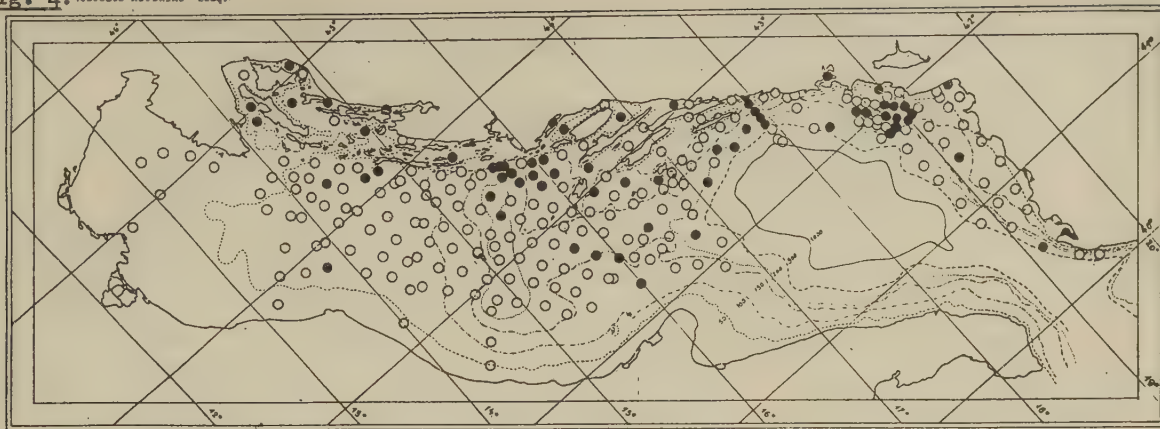


Fig. 5: ● *OXYNOTUS CENTRINA* (L.) ⊕ *SQUATINA SQUATINA* (L.)

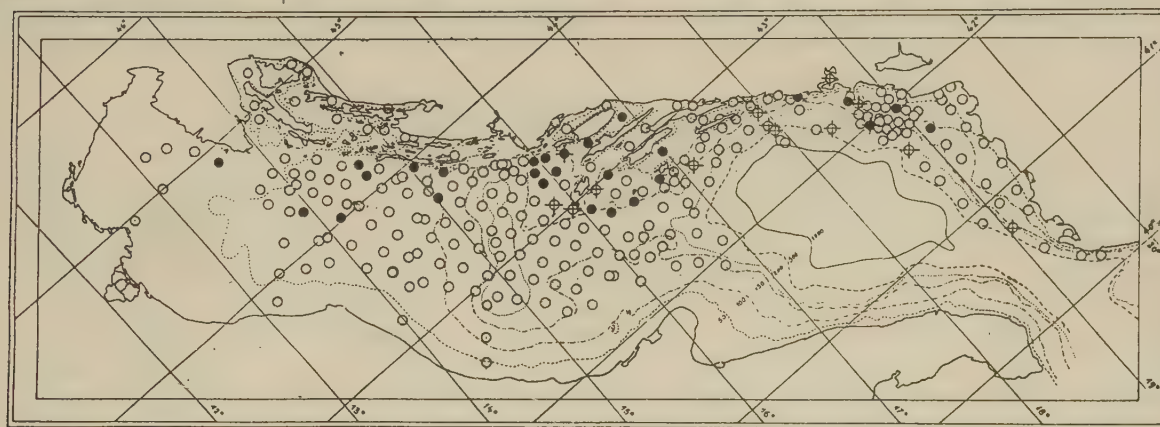


Fig. 6: ● *SQUALUS ACANTHIAS* L. ⊕ *CENTROPHORUS GRANULOSUS* (Schn.) □ *ETHOPTERUS SPIRAX* (L.)

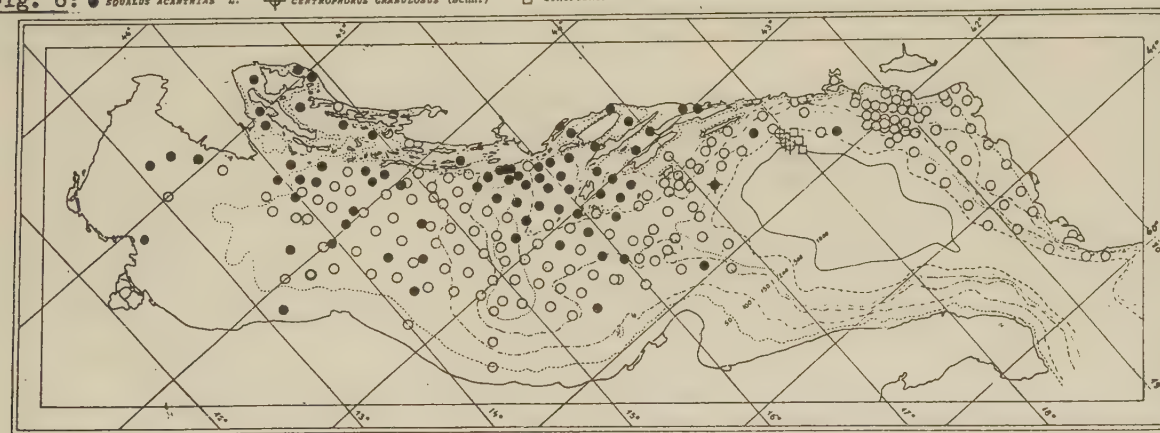


Fig. 7: ● *SQUALUS BLAINVILLEI* (Risso) ⊕ *ECTHNOUREUS LICHIA* (Bonn.)

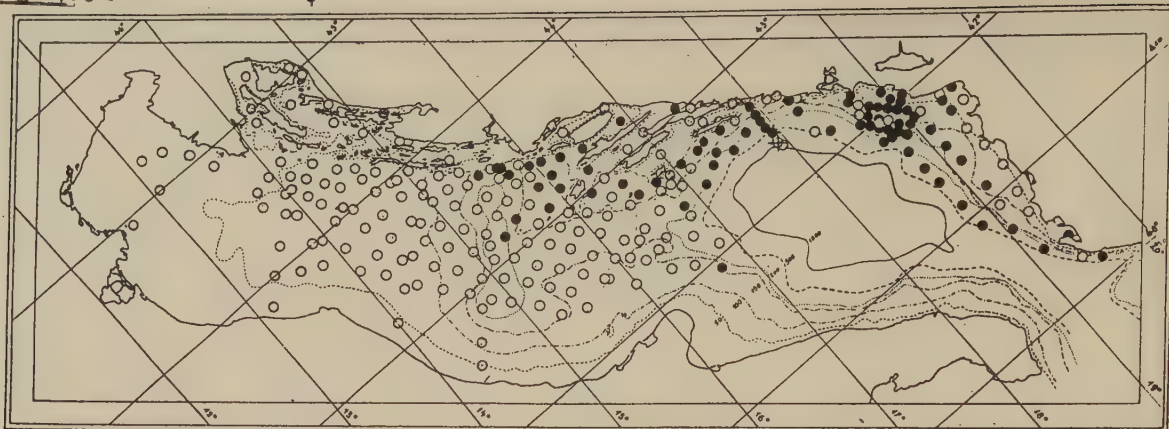


Fig. 8: *TORPEDO (TORPEDO) HARMORATA* Risso

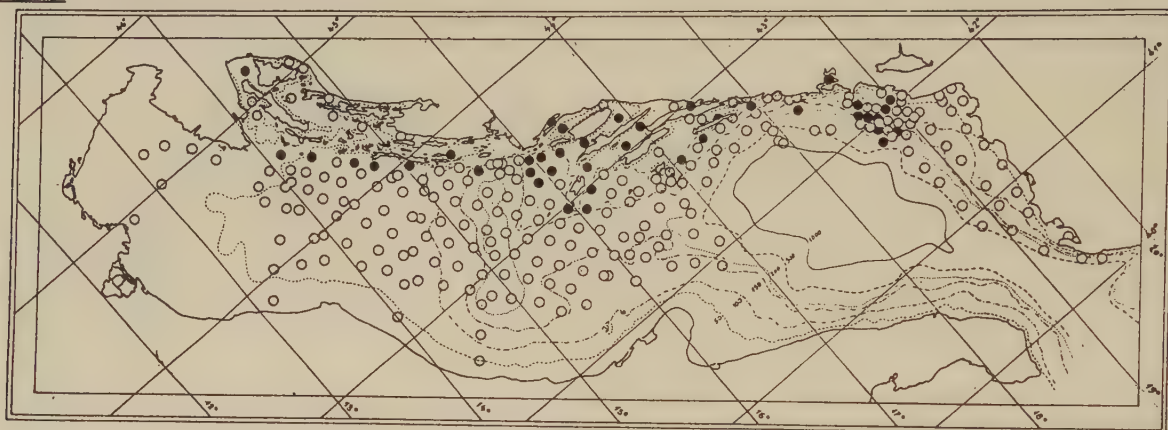


Fig. 9: ● *RAJA (RAJA) HIRALATUS* L. ⊕ *RAJA (RAJA) NORTAOUZ* Foml.

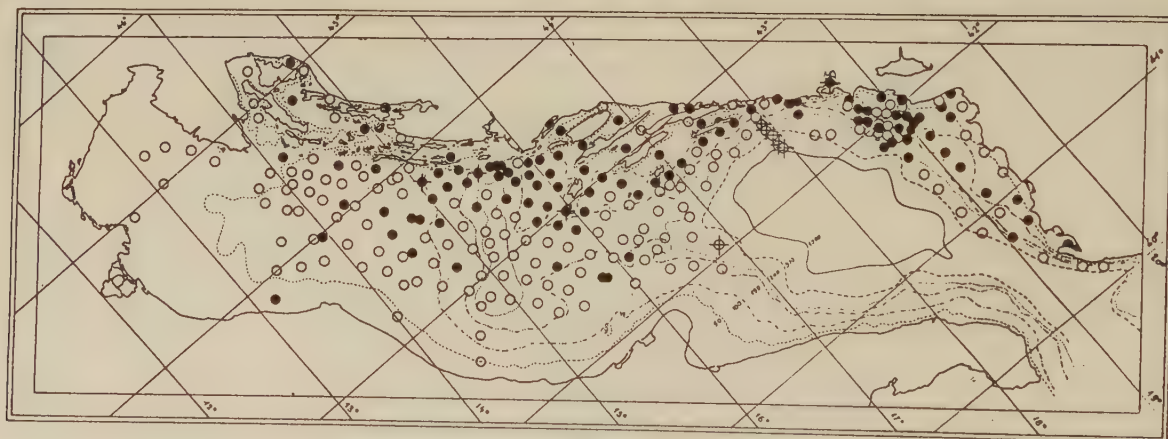


Fig. 10: ● RAZA (RAJA) ASTERIAS Delat. ◆ RAZA (DEPTURUS) BATES L. ● RAZA (ROSTROHAJA) ALBA Lac. ✦ RAZA (LEUCORAJA) CIRCULARIS Couch

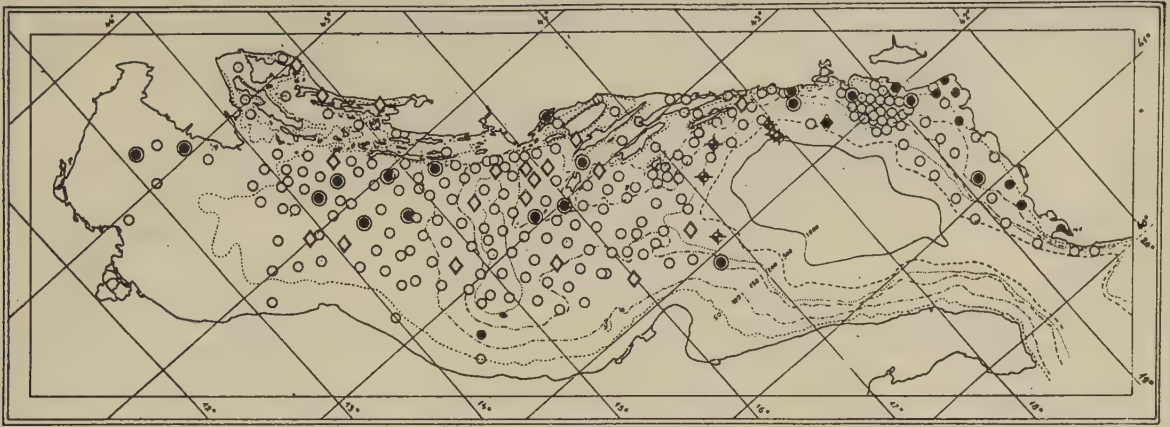


Fig. 11: RAZA (RAJA) CLAVATA L.

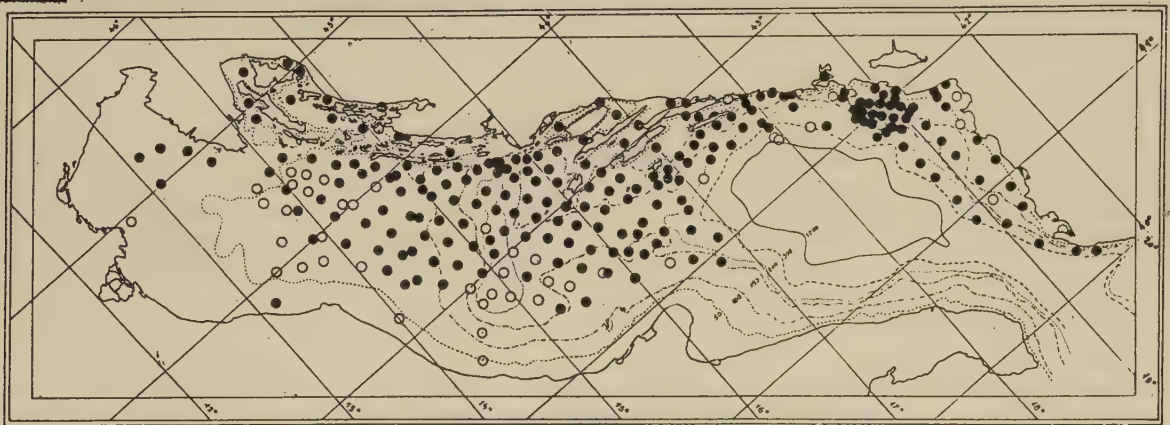


Fig. 12: ● RAZA RADULA Delat. ● RAZA (DEPTURUS) OXYRINCHUS L.

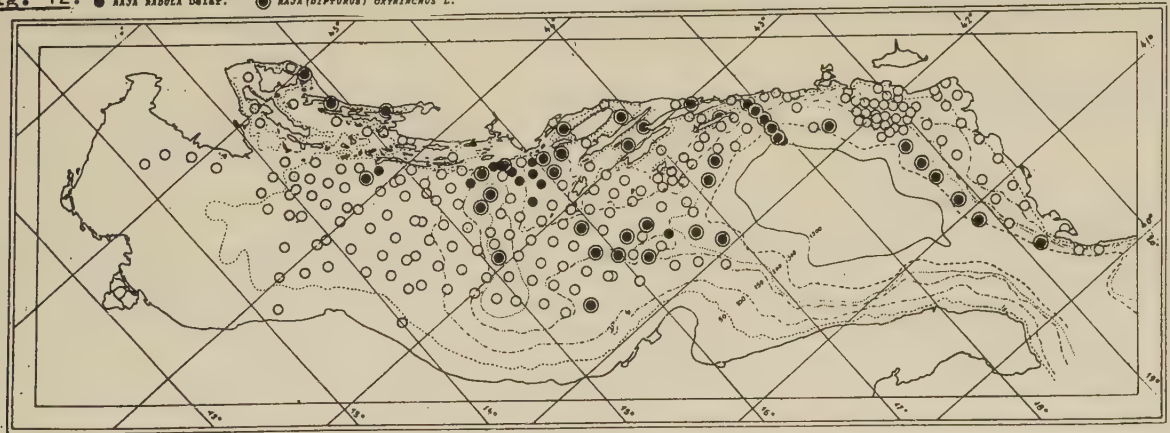
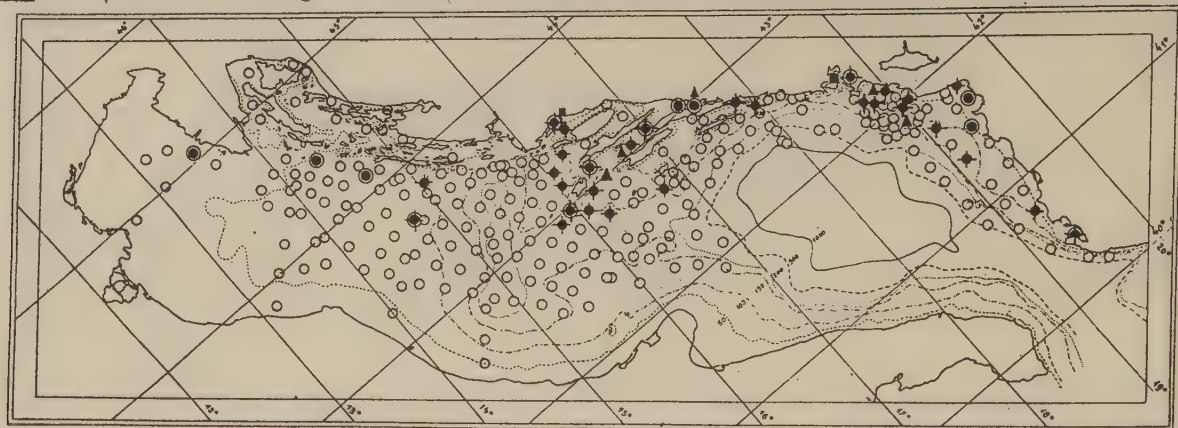


Fig. 13: ◆ *DASYATIS PASTINACA* (L.) ● *HYLIOBATIS AQUILA* (L.) ■ *PTEROMYLAUS BOVINUS* (Geoffr.) ▲ *DASYATIS CENTRoura* (Mitch.)



ANNEXE L / APPENDIX L

Preliminary utilization of trawl survey data for hake
(*Merluccius merluccius* L.) population dynamics in the Adriatic Sea

by

C. Flamigni

Laboratorio di Biologia Marina e Pesca - Fano, Italy

1. INTRODUCTION

This work examines the results of two trawls surveys carried out in May and November 1982 by the Laboratory of Marine Biology and Fishery in Fano, in collaboration with the Institute of Oceanography and Fisheries in Split; the area concerned was the North and Central Adriatic, except the Yugoslav territorial waters. Hake (*Merluccius merluccius* L.) resulted to be present in the whole sampled area, except the region North of the Po's delta; this fact was more evident in May than in November, when the species appeared more uniformly distributed on a larger portion of the Adriatic.

2. LENGTH/WEIGHT RELATIONSHIP

Length/weight relationship parameters are summarized in Table 1, where for each value the 95 percent confidence limits are indicated.

3. GROWTH

Table 2 shows the average length of the different age groups as determined by means of otoliths readings. The 95 percent mean length confidence limits and the number of the specimens examined (n) are indicated for each age group. These data were used to compute growth parameters according to the "Ford-Walford Plot", for regular intervals of about six months. However, it was necessary to exclude class 0, not yet completely recruited and therefore underestimated as for the number of individuals and overestimated as for the mean length. We have:

$$L_{\infty} = 85.0$$

$$K = 0.12$$

It should be underlined that even slight slope variations in the regression line can remarkably alter the estimated values of L_{∞} and K. Therefore a merely indicative value can be given to such an estimate. Anyway, the values computed by Zupanović (1968) are confirmed.

4. LENGTH FREQUENCY

Length frequency distribution is represented in figure 1. In May there is an almost unimodal distribution. In November a new mode appears, corresponding to new recruits, leading to a bimodal distribution.

The disaggregation of these data for geographic areas seems to be particularly interesting. For this purpose we grouped the stations presenting a similar length frequency distribution, thus dividing the area considered into three zones (Figure 2).

In May, two frequency peaks can be observed in the deepest waters of the Central Adriatic (Figure 3 C): a very marked one at 11-13 cm; a far less evident one at 25-30 cm, in correspondence with hake first sexual maturity, indicating a concentration of spawners in this zone. Leaving the spawning area, the peak of the youngest individuals shifts to 15-16 cm (Figure 3 B) and there is also a large amount of hake of 17-21 cm, almost absent in the previously mentioned area. All this is in accordance with the existence of a trophic migration of immature young hake towards shallower waters, richer in food; once sexual maturity is reached, hake go back to the deepest waters (Zupanović, 1968). In the more northern stations length frequency is much more uniform (Figure 3 A).

In November hake appear more uniformly distributed (Figure 4). The different seasonal geographic distribution is also in accordance with the observations relating to the degree of sexual maturity. In May, the higher concentration of young individuals and spawners in the deepest waters is in fact accompanied by a higher percentage of sexually mature females, whereas in November such percentage is considerably lower.

5. MORTALITY

The method used (Pauly, 1980) implies the assumption of constant recruitment and therefore it should be checked on a multi-year basis. The total mortality coefficient Z is estimated by means of a catch curve based on lengths converted to ages (Figure 5). We have:

$$\text{May: } Z = 0.92 \pm 0.08$$

$$\text{November: } Z = 1.05 \pm 0.16$$

(the 95 percent confidence limits are indicated).

Table 1
Length/weight relationship parameters 1/

	May			November		
	a	b	n	a	b	n
males	- 2.364 ± 0.011	3.16 ± 0.13	84	- 2.6095 ± 0.0088	3.35 ± 0.11	161
females	- 2.460 ± 0.020	3.26 ± 0.20	59	- 2.5398 ± 0.0077	3.317 ± 0.072	256
males + females + undetermined	- 2.5017 ± 0.0056	3.274 ± 0.039	475	- 2.4594 ± 0.0067	3.250 ± 0.042	628

1/ $\log_{10} W = b \log_{10} L + a$

Student's "t" between males and females:

May: $t = 1.66$
($df = 139$)

November: $t = 0.99$
($df = 413$)

Student's "t" between May and November:

Males: $t = 4.34$ 2/
($df = 241$)

Females: $t = 1.73$
($df = 311$)

M. + F. + undetermined: $t = 1.61$
($df = 1099$)

2/ Significant difference at the 1 percent level.

Table 2

Average lengths of the different age groups, determined by means of otolith examination (cm)

Age group	May	November
0	-	11.0 ± 0.4 (n = 100)
1	14.3 ± 0.3 (n = 273)	19.0 ± 0.3 (n = 228)
2	21.3 ± 0.6 (n = 151)	26.2 ± 0.4 (n = 228)
3	29 ± 1 (n = 52)	33.3 ± 0.7 (n = 70)
4	35 ± 3 (n = 8)	39 ± 5 (n = 3)

In the two seasons the catch curves show the same patterns for fish older than 3 years, either for the slope of for the absolute frequencies. This seems to confirm the reliability of our estimate of Z for this age interval. On the contrary the catch curves are different in May and November for fish younger than three years; this fact prints out the need for further investigations and more detailed data concerning, as far as possible, all the seasonal aspects.

Pauly (1980) gives an empirical formula to obtain an indicative estimate of the natural mortality M starting from L_{∞} , K and T (mean environmental temperature). It would follow that:

$$Z \approx 1; M \approx 0.25; F = Z - M \approx 0.75.$$

Our value can be compared with those estimated by Zupanović (1968), $Z = 0.78$, and by Hernandez et al. (in press) $Z = 0.76$.

Table 3 compares the observed numbers at age with those expected under the assumption of full recruitment at all ages and equilibrium situation (constant recruitment, $Z = 1$. In order to do this, all the specimens caught during the two surveys were ascribed to an age group, according to the mean lengths experimentally determined and the growth parameters.

An important deficit in observed numbers (less than half the expected value) is recorded for age class 1 in November. This may indicate higher mortality rates between May and November for young fish than for older ones but seasonal changes in availability and migrations are other important aspects that must probably be taken into account when trying to interpretate the phenomenon because the length frequency distribution used here are not annual ones and are therefore susceptible to seasonal variations.

Table 3

Age group	Expected N		Experimental N		Variations (%)	
	May	November	May	November	May	November
1	2834	1719	2834	707	-	- 59
2	1043	632	1032	611	- 1	- 3
3	384	233	394	266	+ 3	+ 14
4	141	86	174	55	+ 23	- 36

6. MIGRATIONS

The migrations can considerably influence mortality estimates. For example the strong decrease in absolute frequency of hake of class 1 from May to November is also accompanied by a considerable modification of their geographic distribution. In fact, whereas in May 38 percent is still in zone C and only 4 percent has reached zone A, in November many of them are much farther from the spawning area out of feed needs, so that only 20 percent has remained in zone C, whereas their percentage has risen to 25 percent in zone A. If we add to this fact that hake in their trophic migration concentrate particularly along the Yugoslav coasts (Jukić and Piccinetti, 1981), that is out of the Adriatic area covered by our trawl surveys, it cannot be excluded that part of the one year hake population sampled in May escaped the November trawl survey because of a migration out of the area considered.

These considerations, together with the variations in the recruitment from year to year, make us defer a more exact mortality estimate to a future when an additional number of data relative to different years and the whole Central and North Adriatic, including the Yugoslav coastal waters, will be available.

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Figure 1: Total length frequency distribution cumulative of each trawl survey.

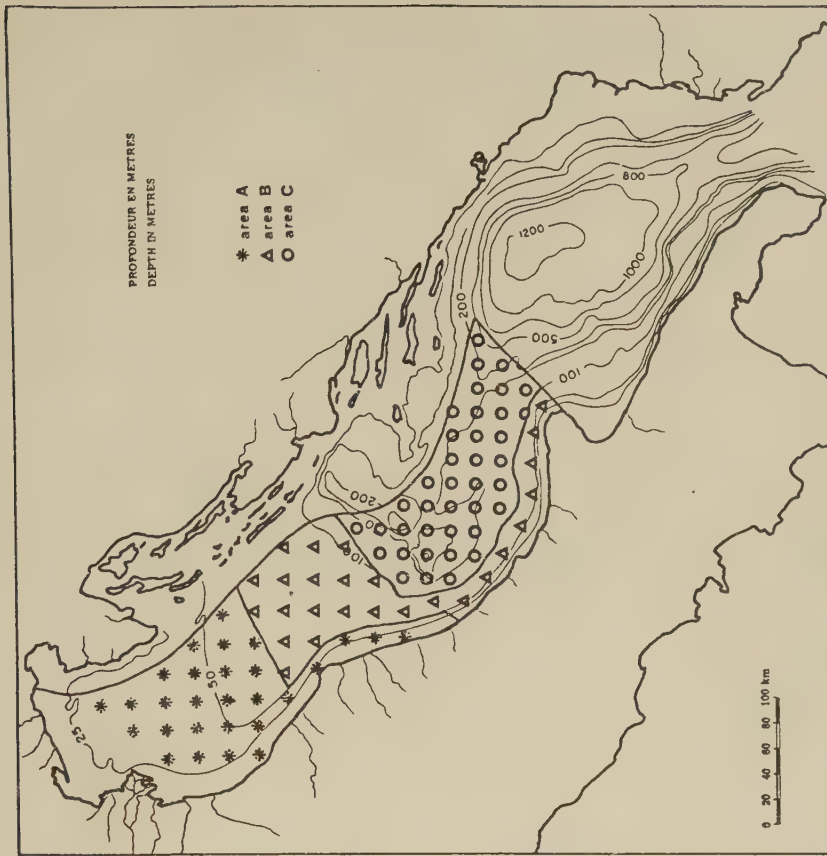


Figure 2: Division of the Adriatic into zones characterized by different length frequency distribution.

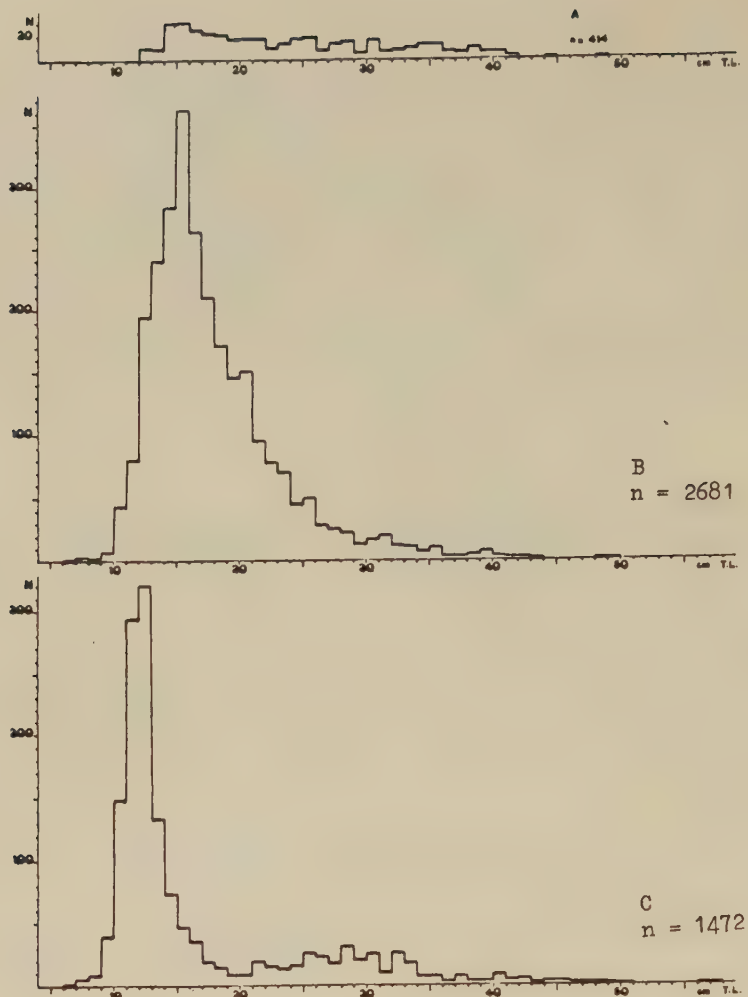


Figure 3: Length frequency distribution in the three zones indicated in Figure 2 (May 1982).

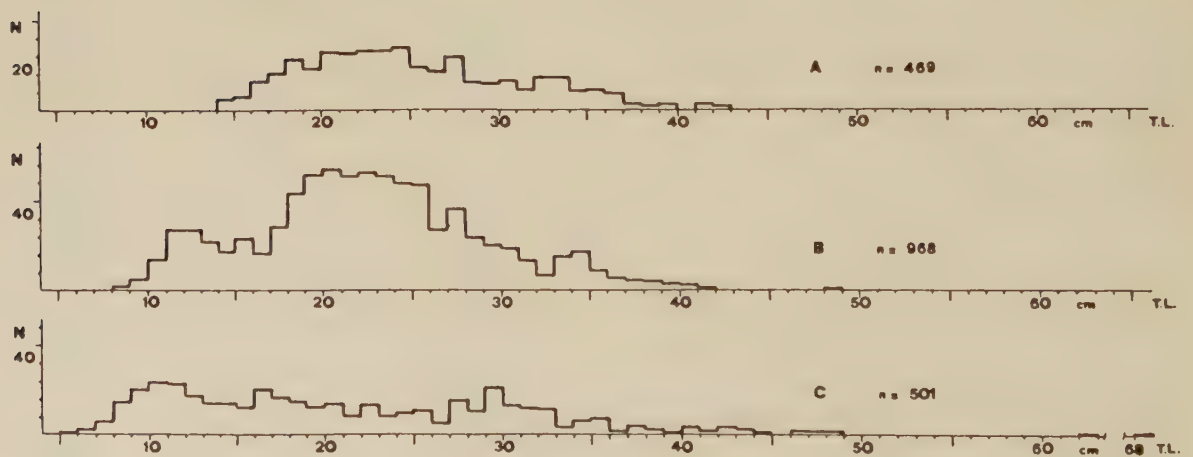


Figure 4: Length frequency distribution in the three zones indicated in Figure 2 (November 1982).

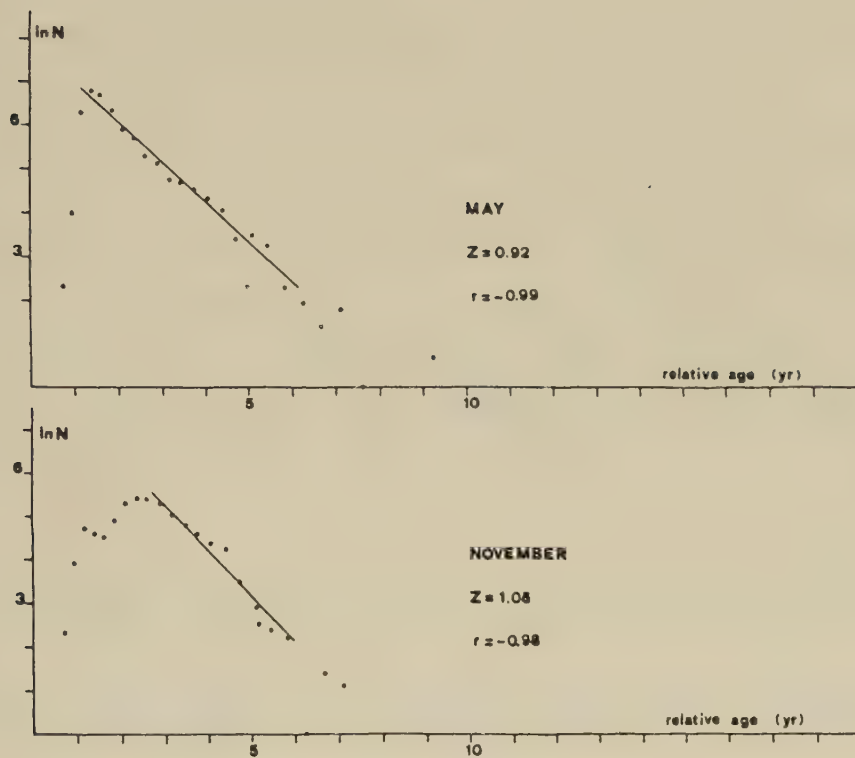


Figure 5: Catch curve based on lengths converted to ages for estimation of total mortality.

ANNEXE M / APPENDIX M

Données biologiques sur Solea vulgaris Quensel en Adriatique

par

C. Piccinetti et O. Giovanardi
Laboratorio di Biologia marina e Pesca - Fano, Italie

1. DISTRIBUTION

Cette espèce présente une distribution différente en fonction de l'âge et des conditions physiologiques.

Après la métamorphose, les petites soles se trouvent dans les eaux saumâtres à très faible profondeur le long des côtes italiennes, en particulier dans les lagunes voisines des bouches du Pô.

A partir de la taille de 12-15 cm, les soles sont réparties sur une bande côtière de quelques milles le long de la côte italienne; à partir de l'âge d'un an, on les trouve sur la plupart des fonds de la haute et moyenne Adriatique jusqu'à la profondeur d'environ 100 mètres (Figure 1).

On a vérifié, au moyen de marquages, l'existence en Adriatique de déplacements notables de soles; au sud du Pô, elles se déplacent le long des côtes italiennes jusqu'au promontoire du Gargano; au nord du Pô, il n'y a pas une direction constante de déplacement. Au cours de la période septembre-novembre pour les soles de la classe 0, les déplacements sont plus actifs; un déplacement de la côte vers le large, qui a lieu après le déplacement vers le sud, est évident. Des investigations sont en cours pour vérifier l'existence d'un retour vers le nord de l'Adriatique qui, probablement, a lieu à l'état d'oeufs et de larves.

2. CROISSANCE

Il existe des variations de la croissance d'une année à l'autre et d'une zone à l'autre en fonction principalement du mois de naissance et des conditions écologiques. Ceci peut expliquer une partie des différences dans la croissance indiquée par différents auteurs.

En général, les soles arrivent à leur premier hiver (environ 10-12 mois) à une taille de 18 à 20 cm; à leur deuxième hiver elles mesurent entre 21 et 30 cm; au cours des années suivantes, la fourchette des tailles au même âge est encore plus grande.

La croissance est active au printemps et en été tandis qu'elle est très faible entre décembre et mars. Par marquage on a vérifié la variabilité de la croissance d'exemplaires qui s'accroissent de 2 cm par mois et d'autres, du même âge, de 2 cm par an.

Sur un échantillon de soles capturées en février 1982 dans la zone côtière (Figure 2) de tailles comprises entre 15 et 30 cm, on a obtenu les paramètres de croissance suivants, pour l'ensemble des mâles et des femelles, par la méthode de Walford :

$$K = 0,679 \quad L_{\infty} = 40,10 \text{ cm.}$$

La relation entre longueur totale et poids est la suivante :

M + F	$P = 0,693 \cdot 10^{-2}$	$1^{3,084}$
F	$P = 0,571 \cdot 10^{-2}$	$1^{3,143}$
M	$P = 0,864 \cdot 10^{-2}$	$1^{3,013}$

Dans la Figure 3 est reportée la courbe longueur-poids.

3. REPRODUCTION

Les soles se reproduisent en Adriatique en hiver, entre novembre et mars; les soles de plus grande taille se reproduisent plus précocement. La zone de ponte semble être toute la zone de distribution des adultes, mais il y a aussi des zones de concentration de reproducteurs, comme les côtes de l'Istrie.

Les ovocytes présents dans le même ovaire ne sont pas mûrs en même temps; ceci pourrait indiquer l'existence d'une ponte fractionnée et il est difficile de déterminer la fécondité.

Des femelles de 300 grammes avaient 150.000 oeufs de plus de 200 μ dans les ovaires et des femelles de 400 grammes, 250.000.

Le rapport mâles/femelles est en moyenne de 1.

4. MORTALITE

En utilisant l'équation de Pauly (1980) on obtient une mortalité naturelle $M = 0,9$. Avec la méthode de Tanaka (1960) on a une valeur de $M = 0,6$.

La mortalité totale Z , estimée en utilisant les paramètres de croissance, la taille de première capture et la taille moyenne de capture est de 2,0.

Si l'on utilise des courbes de capture qui ne considèrent pas la classe 0, on obtient $Z = 1,4$.

La mortalité par pêche est supérieure à la mortalité naturelle.

5. SELECTIVITE

Les expériences de sélectivité réalisées avec le "rapido", engin utilisé pour la pêche des soles, montrent un facteur de sélectivité variant entre 3,4 et 4,0. Avec le maillage couramment utilisé par la plupart des pêcheurs, L_{50} est supérieur à 150 mm.

6. EVALUATION DE LA PRODUCTION

Les captures des soles en Adriatique ont fluctué dans les vingt dernières années entre 1300 et 3000 tonnes; l'engin de pêche le plus utilisé est le "rapido". La production est plus élevée au cours des mois d'octobre et de novembre, quand la nouvelle classe d'âge entre dans les captures.

La production annuelle présente des fluctuations notables en relation avec la consistance du recrutement.



Figure 1 - Répartition de Solea vulgaris et CPUE (kg/h), "Pipeta" II, novembre 1982.

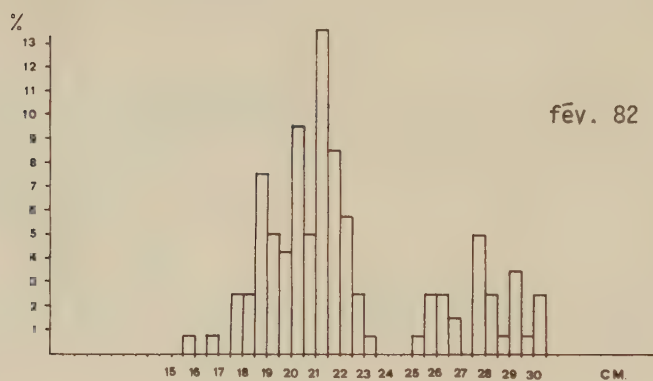
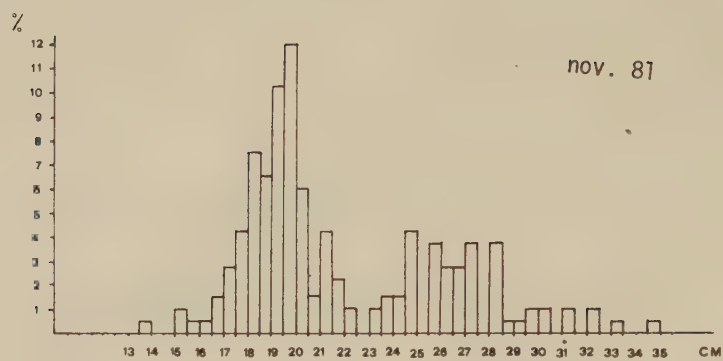


Figure 2 - Répartition par taille des captures avec le "rapido" dans la zone côtière.



Figure 3 - Corrélation longueur-poids (nov. 81)

ANNEXE N / APPENDIX N

Some aspects of horse mackerel (*Trachurus trachurus* L.) biology in the Adriatic

by

V. Alegria

Institut za oceanografiju i ribarstvo - Split, Yugoslavia

1. INTRODUCTION

Horse mackerel (*Trachurus trachurus* L.) make up a significant part of Yugoslav commercial catches. They are present in trawl catches as a very important component (after a long-term series, on average, 35 per cent) as well as in purse-seine catches (2 per cent) together with sardine.

2. DISTRIBUTION

This species is widely distributed in the Adriatic sea (Figure 1). The richest trawl fishing grounds are in the areas of Blitvenica and Jabuka Pit at depths ranging from 100 to 200 m.

3. REPRODUCTION

The spawning season extends from February to July and most intensive spawning period is in April-May.

Horse mackerel spawn in the open Adriatic between 100 and 200 m isobaths, at temperature of 12.0 - 16.0°C and 38.5 - 38.8‰ salinity (Karlovac, J. and O. Karlovac, 1971).

Sexual maturity is reached at a size of 150-180 mm total length, at the end of the first year of age.

More advanced gonad maturity states were recorded mainly in winter - spring period.

4. GROWTH

The otoliths were used for age determination. Age is relatively easily determined in horse mackerel not older than 4-5 years. However, it is far more difficult in older and larger fish. Preliminary results ($n = 228$) after von Bertalanffy equation are (Figure 2).

$$L_{\infty} = 375.5 \quad K = 0.22 \quad t_0 = -1.28$$

Length-weight relationship calculated from seasonal samples with a total of 1,726 specimens, grouped by length classes of 140 to 350 mm, is:

$$W = 1.21 \times 10^{-5} L^{2.9176}$$

This relationship for the period of spawning is:

$$W = 1.63 \times 10^{-5} L^{2.8558}$$

and for the period of sexual inactivity:

$$W = 0.58 \times 10^{-5} L^{3.0552}$$

5. CATCH ANALYSIS

Length composition of experimental catches shows that three groups may be distinguished. The first group with juveniles of 50-120 mm length, the second with adult individuals of 170-260 mm in length and the third with the biggest individuals (Figure 3).

Fish of 170 to 250 mm were predominant in commercial catches. The major part of horse mackerel were less than 6 years old; II, III and IV year classes prevailed.

From the 24 year data series (1956-1979) of trawl catches, horse mackerel population abundance, measured as c p u e, was on the average 180.75 kg/trawling day, with a negative development trend ($b = -7.64 \text{ kg/year}$).

6. REFERENCES

Karlovac, J. and O. Karlovac, Contribution à la connaissance de l'écologie de *Trachurus trachurus* (L.) 1971 au large de l'Adriatique. The M.V. Hvar cruises. Researches into biology, 1948-1949. Izv. Inst. Oceanogr. Ribar., Split, 5(2A):24 p.

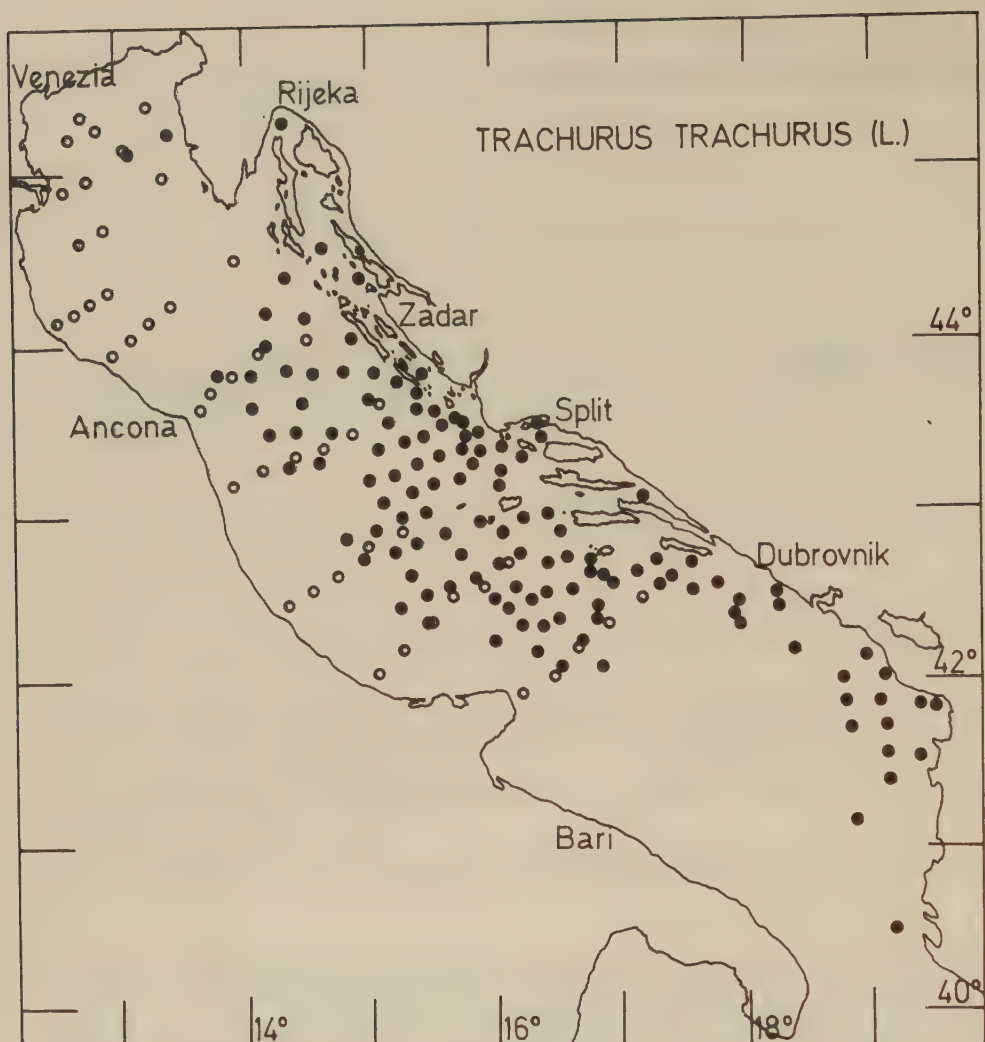


Figure 1: Distribution of *Trachurus trachurus* L. in the Adriatic sea. From "Hvar" Expedition data and I.O.R. unpublished data.

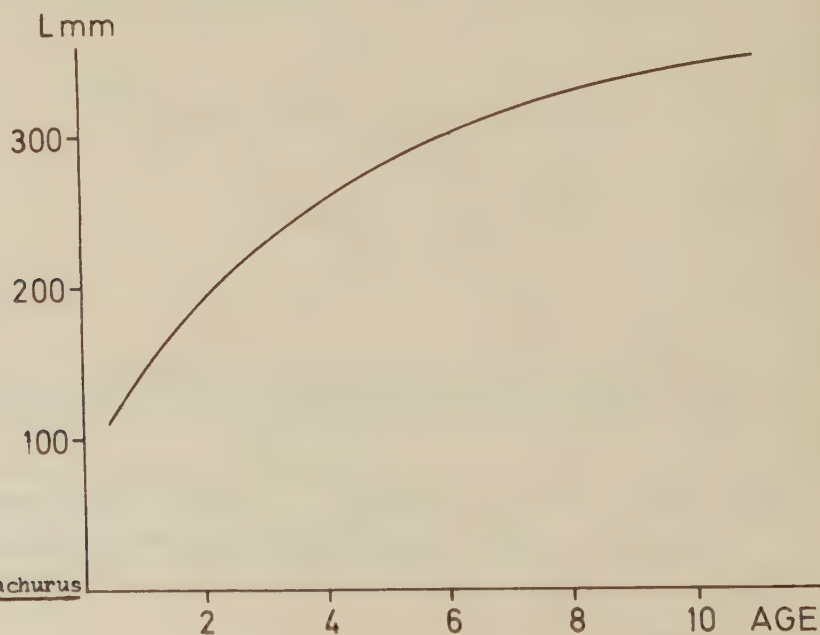


Figure 2: Growth curve of *Trachurus trachurus*

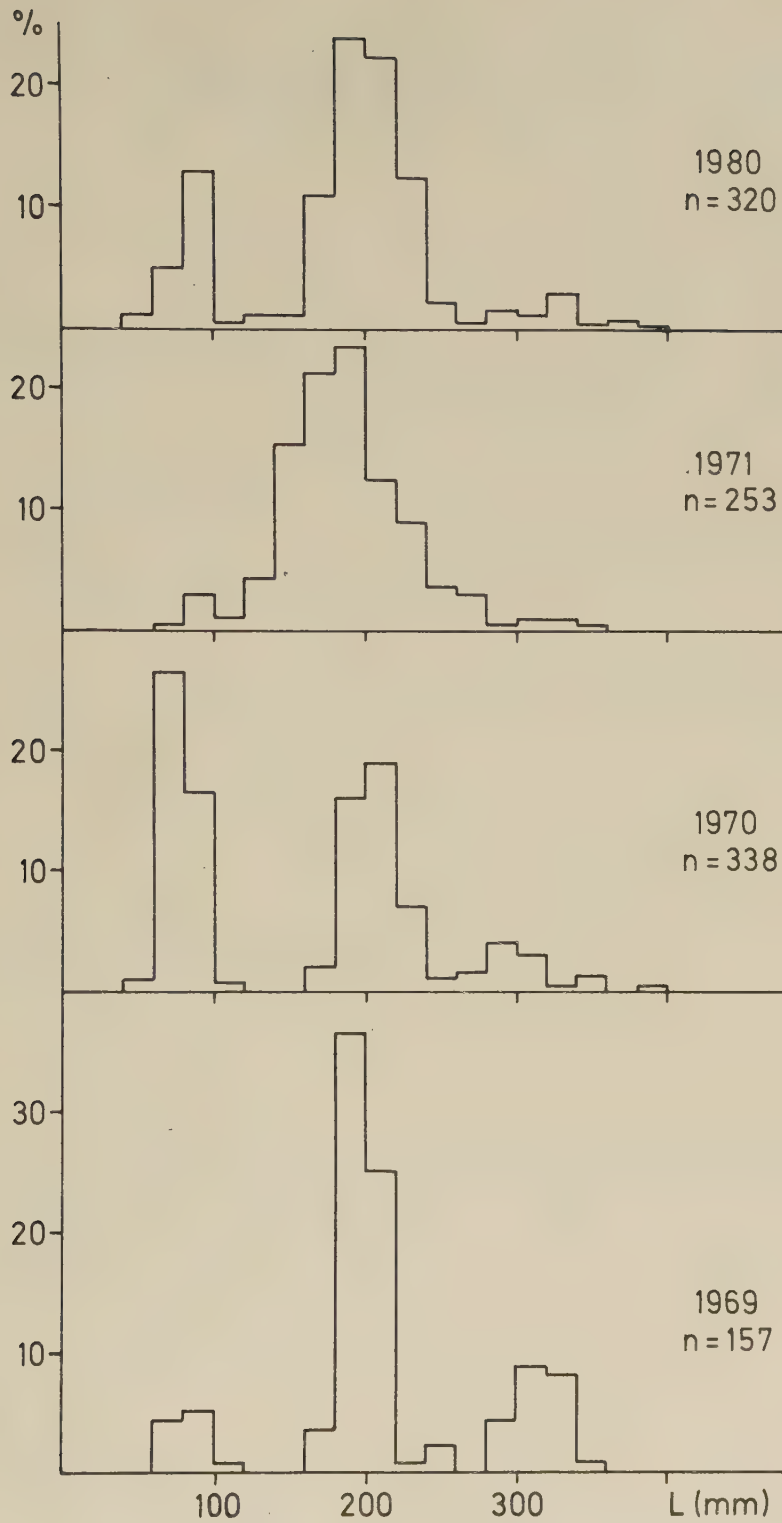


Figure 3: Size frequency distribution observed in samples of experimental catches in Jabuka Pit and Blitvenica.

ANNEXE 0 / APPENDIX 0

Biological data collected during the Pipeta expeditions on
Trachurus mediterraneus (Steindachner) in the Adriatic Sea

by

E. Arneri and P. Tangerini

Laboratorio di biologia marina e pesca - Fano, Italie

1. DISTRIBUTION AND RELATIVE ABUNDANCE

As shown in figures 1 and 2, Trachurus mediterraneus is a common species in the Adriatic sea; it has been caught in the whole area investigated during the two cruises (May and November 1982).

In November catches per unit effort are higher: in this period there is a bigger amount of juveniles in the coastal water.

Figure 3 represents the size frequency distribution of all specimens caught: the main bulk of the catch is formed by year class 1; probably the catch of year class 0 is affected by trawl - net selectivity or by a more coastal distribution.

2. GROWTH

The growth pattern has been studied for mixed sexes by means of otoliths and length frequency distribution:

CLASS	0	1	2	3
May	/	12.4 (n = 162)	18.3 (n = 354)	23.4 (n = 39)
November	11.1 (n = 165)	17.9 (n = 932)	22.2 (n = 110)	26.0 (n = 10)

A length - weight relationship was computed with samples collected in May; it is based on 560 specimens ranging from 8 to 34 cm.

$$W = 0.00555 \text{ TL}^{3.105}$$

N = 560

W = Weight in g.
TL = Total length in cm.

3. REPRODUCTION

Spawning period is mainly late spring and summer. In May females have mature ovaries or not far from complete maturity; in November all females caught have resting gonads. The spawning area corresponds to the distribution area with the probable exception of upper part of the northern Adriatic, where very few mature specimens were caught.

Sexual maturity has been reached by the major part of specimens at the second year of life and at a size bigger than 16 cm. (TL).

Sex - ratio shows a prevalence of females:

M/F = 0.76	May	N = 399
M/F = 0.49	November	N = 405

4. MORTALITY

Using catch curve method (Pauly, 1983) total mortality values have been computed for the two surveys:

May	Z = 0.98	overall N = 1.536 from 17 cm to 27 cm
November	Z = 0.99	overall N = 3.007 from 17 cm to 25 cm

5. REFERENCE

Pauly, D., Some single methods for the assessment of tropical fish stocks. FAO Fish. Tech. Pap.; 1983 (234): 52 p.



Figure 1: Mean catches (kg/h) in May. (T = traces)



Figure 2: Mean catches (kg/h) in November.

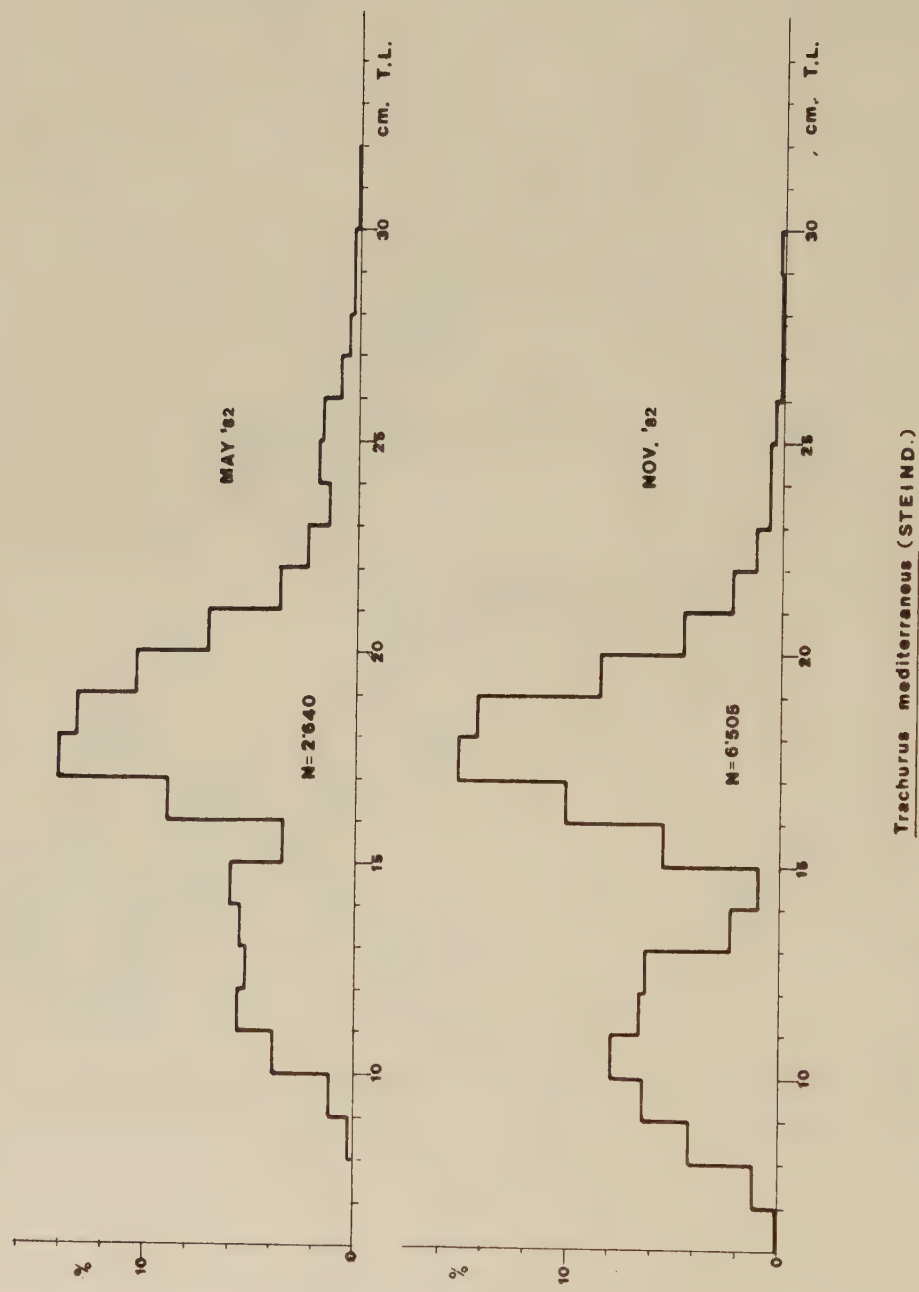


Figure 3: *Trachurus mediterraneus*. Size frequency distribution.

ANNEXE P / APPENDIX P

Summary of biological parameters
of *Squilla mantis* L., in the Adriatic sea

by

O. Giovanardi and G. Piccinetti Manfrin
Laboratorio de Biologia marina et Pesca - Fano, Italy

1. INTRODUCTION

Squilla mantis L., called "canocchia" is a Stomatopoda (Crustacea) very abundant in the Adriatic sea where the environmental conditions are favourable for its development and propagation. It lives on muddy and muddy-sandy bottoms where it digs deep galleries to shelter during day-time and moulting-time; the females also shelter during the incubation of the eggs that are oxygenated and actively protected.

2. DISTRIBUTION

CPUE (kg/h) of the cruise "Pipeta II" (November 1982) are shown in Figure 1. The typical coastal distribution on soft bottoms up to 50-60 m should be noted.

3. REPRODUCTION

The squill mates in winter-time; spawning takes place from March to June. The spawning area is 1 mile off the coast (about 10 meters deep); this zone shows a higher concentration during spawning months. The eggs are laid as a gelatinous mass up to 14 cm. in diameter. According to Giesbrechi (1910) the fecundity of the species is around 50.000 eggs per female.

Larval and pelagic stages are found up to October-November. Generally, in the southern Adriatic, spawning takes place earlier than in the colder northern Adriatic.

Sexually mature females smaller than 12 cm (total length) have never been found.

Sex-ratio is very variable with time and areas. During the spawning season, the females hide in the galleries and are therefore less vulnerable than males. In this case sex-ratio (M/F) is relatively high.

4. GROWTH

The squill would change to the "littoral" benthonic stage at a length of 17-20 mm.

Size frequency distributions usually show a slightly faster growth for males than for females. After 1 year of life the total mean length is 80 mm; so the squill spawns only after 2 years. The maximum length found has been 198 mm, while the most frequent length classes in the landings are 14-16 cm. The size frequency distributions for "Pipeta I - II" cruises (by "tartana") in May and November 1982 are shown in Figure 2.

Length-weight correlations, relative to November 1982, are the following :

$$\begin{array}{lll} W = 0.0116 L^{3.0431} & n = 71 & \text{Males} \\ W = 0.0138 L^{2.9168} & n = 128 & \text{Females} \end{array}$$

5. FEEDING HABITS

From a research carried out on specimens caught in the coastal zone off Fano (Piccinetti - Piccinetti Manfrin, 1970) strictly specific and seasonal requirements should not exist, the diet being very varied.

Out of 296 specimens not having empty stomachs, the following frequency index have been found :

Annelida	(<u>Sabella pavonica</u> , etc.)	1.4 %
Crustacea	(<u>Upogebia</u> spp., Amphipoda and Decapoda)	40.9 %
Gasteropoda	(<u>Nassa mutabilis</u> , etc.)	6.4 %
Bivalvia	(<u>Venus gallina</u> , <u>Aloidis gibba</u> , <u>Solenocurtus</u> spp, etc.)	5.7 %
Cephalopoda	(<u>Alloteuthis media</u> , etc.)	12.2 %
Echinodermata	(<u>Ophiuroides</u> , etc.)	1.4 %
Pisces	(<u>Engraulis encrasicolus</u> , <u>Mullus barbatus</u> , etc.)	19.9 %

About 50 % of the specimens (caught at day-time) were found with empty stomachs (especially from January to March): this is probably in relation to the feeding habits of the species linked to the prevailing nocturnal activity.

Crustacea, which is important for the diet of the squill, have shown, with the increase of size of the squill, a significant decrease in the frequency index.

6. FISHERY

Fishing is carried out all the year; usually November is the month with the highest production; this would be associated to the higher fishing effort practised in that period on the sole stock by means of the "rapido" in the coastal zone, especially at night. The lowest production is in May-June; this could be explained by the movement towards the coast. So there is a fair correlation between the catch of the two species. According to the ISTAT data, the average yearly production from 1978 to 1980 in the Northern and Central Adriatic has been 2,726 tons, i.e. 64 per cent of the total national production of squill.

Digging galleries makes the squill normally less vulnerable to fishery, but bad weather conditions destroy shelters and are followed by big catches.

All these particular aspects and habits must be considered in the management of the stock.

7. REFERENCE

Piccinetti, C. and G. Piccinetti Manfrin, Prime osservazioni sull'alimentazione di
1970 Squilla mantis L. Note Lab.Biol.Mar., Fano, 3(10):249-64

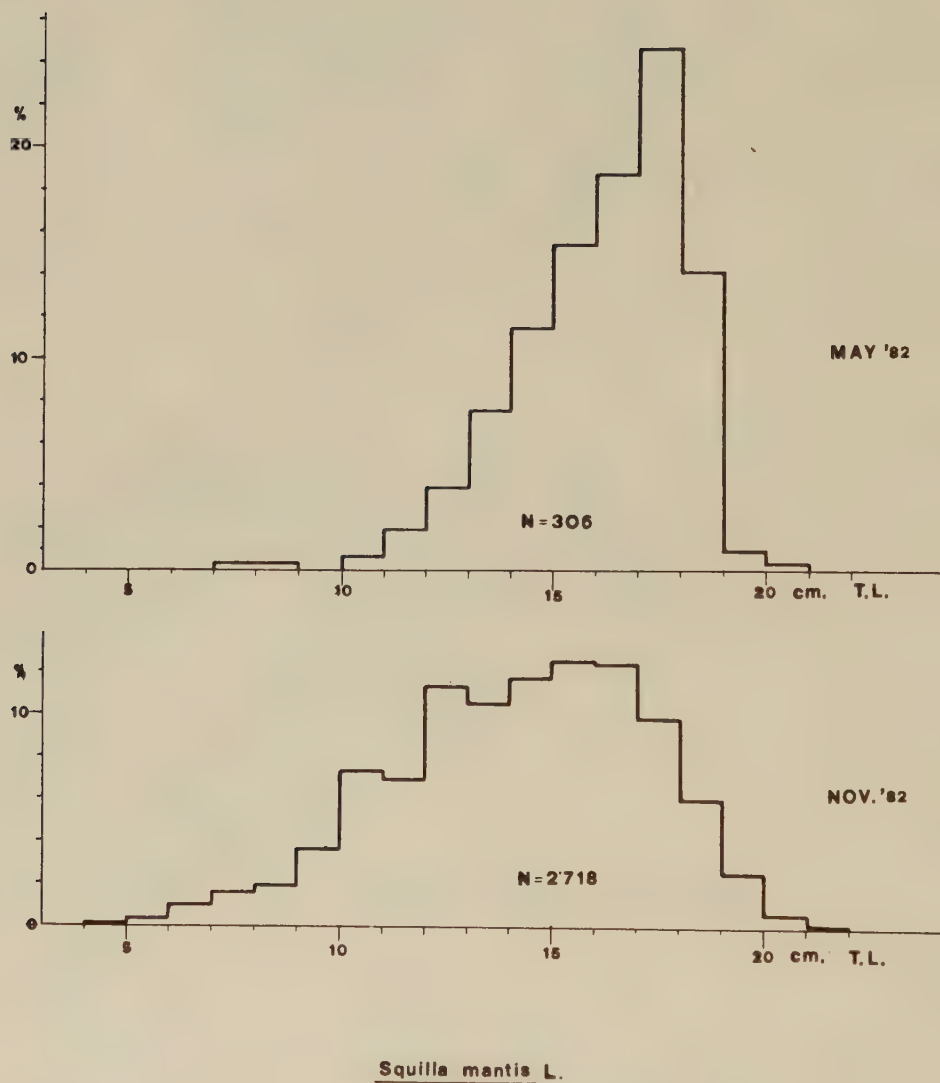


Figure 2 - *Squilla mantis* - Size frequency distribution - Pipeta cruises May and November 1982.

ANNEXE Q / APPENDIX Q

Données sur la biologie de *Sepia officinalis* L. dans l'Adriatique obtenues
lors des expéditions Pipeta

par

G. Manfrin Piccinetti et O. Giovanardi

Laboratorio di Biologia Marina e Pesca - Fano, Italie

1. DISTRIBUTION ET ABONDANCE RELATIVE

La seiche (*Sepia officinalis*) se trouve dans toute l'Adriatique dans les zones à profondeur inférieure à 100 mètres; elle est plus abondante dans l'Adriatique Nord.

Les rendements horaires au cours des campagnes de mai et novembre 1982 (Figures 1 et 2) montrent cette distribution. En mai il y a des rendements élevés à proximité de la côte italienne, surtout entre Rimini et Pedaso, qui sont en liaison avec le déplacement vers la côte pour la ponte.

2. CROISSANCE

La figure 3 représente la répartition par taille (LM = longueur du manteau) des seiches capturées au cours des campagnes.

En mai on a capturé les seiches en reproduction, d'un an d'âge, mais on a aussi trouvé de petits exemplaires ($LM = 4 - 6$ cm) provenant probablement d'une ponte tardive de l'année précédente.

Les captures de novembre comportent pour la plupart des individus nés au cours de la même année. La présence en novembre de seiches très petites confirme l'extension de la période de naissance.

La relation taille - poids a été calculée pour le mois de mai sur des individus allant de 4 à 16 cm de longueur du manteau.

$$P = 0,22041 \cdot LM^{2,773}$$

où P est le poids en grammes et LM est la longueur du manteau en cm.

3. REPRODUCTION

La seiche se reproduit en majorité en avril - mai, mais il y a aussi des pontes en mars, juin et juillet. En novembre, toutes les seiches présentent les gonades au repos.

La reproduction a lieu à partir de la taille (LM) de 10 cm à l'âge d'environ douze mois.

Le rapport des sexes est en faveur des femelles, tant en mai qu'en novembre.

$$M/F = 0,61 \quad \text{en mai}$$

$$M/F = 0,88 \quad \text{en novembre}$$

La ponte est plus intense dans les eaux côtières.



Figure 1: Rendements horaires de capture de Sepia officinalis au cours de la campagne "Pipeta" de mai 1982.

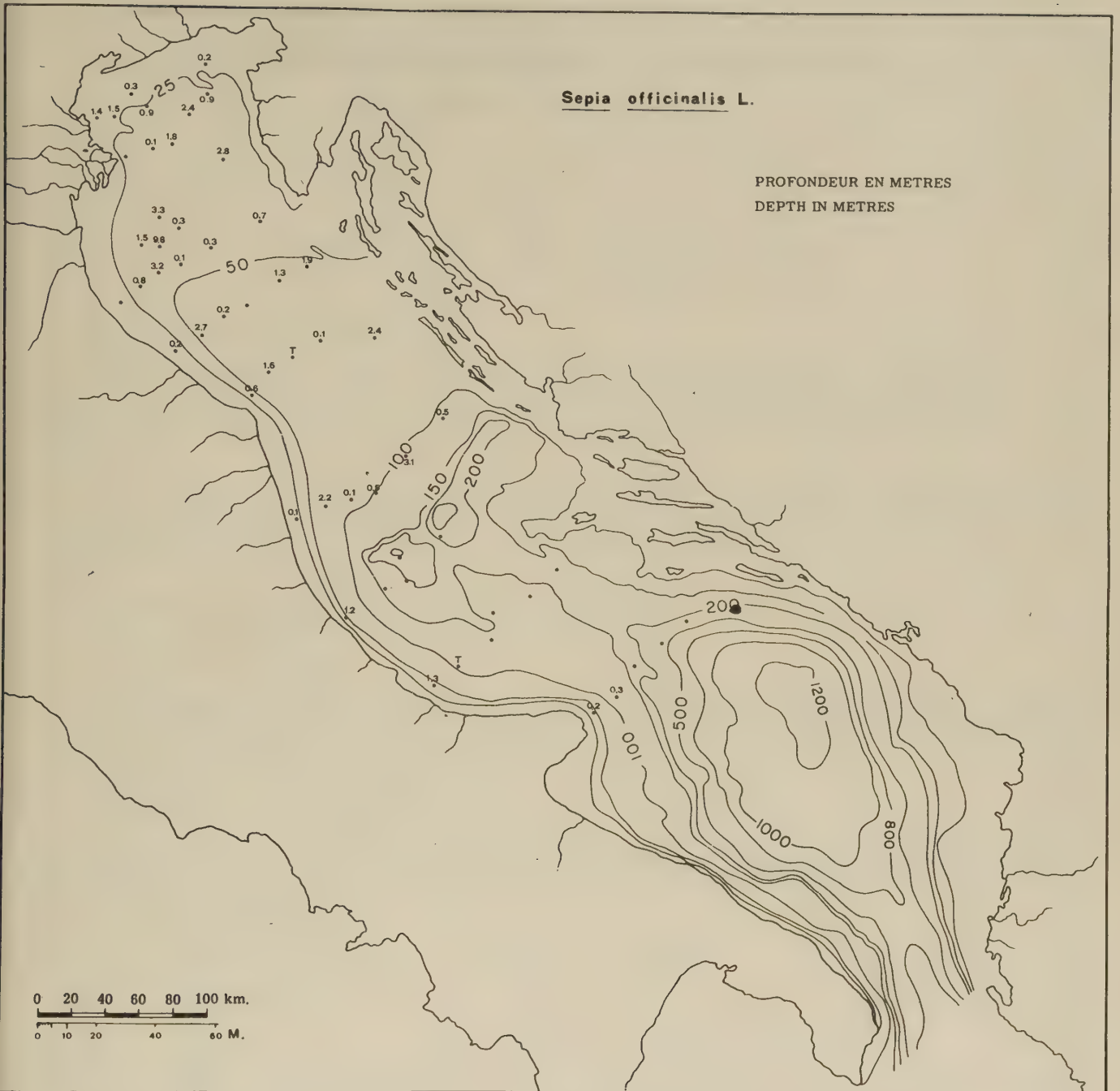


Figure 2: Rendements horaires de capture de Sepia officinalis au cours de la campagne de novembre 1982.



Sepia officinalis L.

FIG. 3

Figure 3: Répartition par tailles de *Sepia officinalis* au cours des campagnes "Pipeta" de mai et novembre 1982.

ANNEXE R / APPENDIX R

Données recueillies au cours des expéditions Pipeta sur la biologie de

Eledone moschata (Lam.) en Adriatique

par

G. Manfrin Piccinetti et M. Rizzoli

Laboratorio di Biologia Marina e Pesca - Fano, Italie

1. DISTRIBUTION ET ABONDANCE RELATIVE

Eledone moschata est répandue surtout en haute Adriatique; cette espèce, le poulpe, se trouve aussi dans une bande côtière étroite le long de la côte italienne. La zone de répartition est comprise entre 30 et 150 mètres de profondeur (Figures 1 et 2). L'abondance du poulpe sur les fonds détritiques du large, en particulier au mois de novembre, justifie l'intérêt des pêcheurs pour cette espèce.

Les différences de rendement entre mai et novembre 1982 s'expliquent par le cycle biologique de l'espèce. En mai il y a le commencement de l'entrée dans les captures des petits poulpes nés pendant l'hiver qui pèsent très peu. En novembre ces individus ont atteint une taille adulte et sont complètement recrutés.

La forte variabilité dans les rendements peut être expliquée par des différences dans les biocénoses qui, en haute Adriatique, varient très rapidement.

2. CROISSANCE

Etant donné les difficultés de mesurer la longueur de cette espèce d'une façon exacte, on a seulement la distribution par poids. En mai, il y a deux classes d'âge: des jeunes qui commencent à être recrutés à environ 5 mois et ont un poids moyen de 50 g, et des adultes en nombre très faible d'un âge d'environ 17 mois et un poids de plus de 500 g.

3. REPRODUCTION

La reproduction a lieu en hiver et s'étend jusqu'au printemps; les poulpes de novembre présentent des gonades en voie de maturation. Le rapport des sexes, calculé pour les captures de novembre, est proche de l'unité

$$M/F = 0,97 \quad (n = 364)$$



Figure 1: Distribution et cpue en kg/h de Eledone moschata (Lam) en mai 1982.



Figure 2: Distribution et cpue en kg/h de Eledone moschata (Lam) en novembre 1982.

ANNEXE S / APPENDIX S

Biological data, collected during the Pipeta expeditions, on the squid *Loligo vulgaris* Lam.
in the Adriatic

by

C. Flamigni and O. Giovanardi

Laboratorio di biologia marina e pesca - Fano, Italy

1. DISTRIBUTION AND RELATIVE ABUNDANCE

The squid is present in all the Northern and Central Adriatic basin and it is less frequent at depths lower than 100 m. (Figures 1 and 2, May and November 1982).

With the exception of the coastal area between Rimini and Ancona in May, particular seasonal high density areas are not detectable.

2. SIZE FREQUENCY DISTRIBUTION

From the size frequency distribution of the two "Pipeta" cruises (Figure 3) one notes that the biggest part of the catch is constituted of specimens just recruited while older big specimens are much less abundant.

The length - weight correlation has been computed on 94 specimens caught in May, ranging from 5 to 25 cm (mantle length).

$$M + F + \text{undetermined} \quad W = 0.04703 \cdot ML^{2.788}$$

Where W is the weight in g. and ML is the mantle length in cm.

3. REPRODUCTION

Total sex - ratio during the two cruises has been the following:

$$M/F = 2.08 \text{ in May} \quad N = 94$$

$$M/F = 1.59 \text{ in November} \quad N = 227$$

Sexually mature specimens have been caught in May and, to a lesser degree, in November, without any particular geographic distribution of the spawners.

The lengths at first sexual maturity found in May were minor for males than for females. Mature males starting from 11.8 cm and females from 15.8 cm (mantle length) were found.



Figure 1: Distribution and cpue (kg/h) of Loligo vulgaris Lam. in May 1982.



Figure 2: Distribution and cpue (kg/h) of Loligo vulgaris Lam. in November 1982.



Loligo vulgaris

FIG. 3

Figure 3: Size frequency distribution in May and November 1982.

ANNEXE T / APPENDIX T

Summary of biological parameters of sardine

(Sardina pilchardus Walb.) from the Central Adriatic 1/

by

Gorenka Sinovčić

Institut za oceanografiju i ribarstvo - Split, Yugoslavia

1. INTRODUCTION

Sardine (Sardina pilchardus Walb.) is widely distributed in the Adriatic, even though it has rarely been caught at depths below 110 m.

Sardine has a considerable importance in Yugoslav commercial fisheries. It made up 55.2 per cent of the total Yugoslav catch in the 1967-1982 period.

2. REPRODUCTION AND FECUNDITY

Sardine spawns in the colder part of the year, from late autumn to early spring (Muzinić, 1979).

Total mean length of analysed sardine specimens at first maturity (L_m) was 14.0 cm. It has been noted as well that sardine specimens attain also full recruitment at the same length (L_C).

$$\frac{L_m}{L_{\infty}} = \frac{L_C}{L_{\infty}} = 0,68$$

Fecundity (F) - total length (L) relationship is

$$F = 0.0391 L^{4.7851} \quad r = 0.980$$

Fecundity - age (A) relationship is

$$F = 7 237.88 A^{1.015} \quad r = 0.991$$

Fecundity-weight (W) relationship is

$$F = 606.596 W^{1.124} \quad r = 0.996$$

3. GROWTH

Values of growth parameters were obtained by von Bertalanffy equation. They are:

$$L_{\infty} = 20.5 \text{ cm} \quad K = 0.46 \quad t_0 = -0.5 \quad W_{\infty} = 86.15 \text{ g}$$

$$\frac{L_{\max}}{L_{\infty}} = 0.98$$

Total length (L) - weight (W) relationship is

$$W = 0.00561 L^{3.0327} \quad r = 0.998$$

Empiric condition factor (C)

$$C = 2.587 \times 10^{-5}$$

and cubic condition factor (K)

$$K = 0.752 \times 10^{-5} \text{ (Alegria, in press)}$$

were estimated.

1/ Data derived from: Sinovčić, G., MS. Estimation of growth and mortality of sardine (Sardina pilchardus Walb.) from the central Adriatic.

4. MORTALITY

Using samples collected from September 1980 to March 1981, the total mortality coefficient (Z) of fully recruited individuals was calculated according to Beverton and Holt (1956) equation and it is

$$Z = 0.736$$

with survival rate

$$S = 0.479$$

Natural mortality coefficient (M) was calculated after Taylor (1959) equation, and it is

$$M = 0.5$$

Fishing mortality coefficient (F) is

$$F = 0.236$$

Exploitation rate (E) is

$$E = 0.321$$

5. REFERENCES

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ANNEXE U / APPENDIX U

Biological data, collected during the Pipeta expeditions, on the whiting,
Merlangius merlangus (L.) in the Adriatic Sea

by

O. Giovanardi and M. Rizzoli

Laboratorio di biologia marina e pesca - Fano, Italy

1. INTRODUCTION

The following data come from samples collected during the two trawl surveys carried out by the "Pipeta", a commercial 300 HP trawler from Fano, in the framework of a scientific cooperation programme between Yugoslavia and Italy.

The specimens caught have shown a wider variability than those described by Bini (1968) as Merlangius merlangus merlangus and by Tortonese (1970) as Merlangius merlangus euxinus; the observed mean number of rays was 18.6 for the second dorsal fin, and 30.0 for the first anal fin.

	II D	I A
Bini	18 - 25	30 - 35
Tortonese	16 - 19	28 - 34
"Pipeta" (n = 191)	15 - 22	27 - 34

2. DISTRIBUTION AND RELATIVE ABUNDANCE (Figures 1 and 2)

The whiting is found in the Northern Adriatic usually down to a depth of 50 m.; it is particularly abundant near the Po River delta.

In May 1982 specimens of this species were caught near the Italian coast as far as the Gargano promontory: these catches were constituted only by small fish of about 14 cm, total length which are generally more abundant in coastal waters: this fact is probably due to the North - South Adriatic coastal stream carrying eggs and larvae.

Data collected in Yugoslavian waters show that this fish is also found in the channels along the northern Adriatic islands down to a depth of about 100 metres.

Catches per unit of effort in November are higher than in May; this seems to be due to the entrance of new recruited fish in the catches.

Figure 3 shows that in May and in November the catch is composed mainly of 0 class born in winter; in November this class appears to have significantly grown.

3. GROWTH

It has been possible to follow the growth of the whiting by means of age determination based on the reading of the otoliths and on the size frequency distribution:

Age				Age			
MALES	0	1	2	FEMALES	0	1	2
	11.2	22.5	25.2	May	11.2	25.5	28.3
	19.4	23.1	/	November	21.5	26.9	30.5

A length - weight relationship was computed with samples collected in May and based on 202 specimens ranging from 6 to 30 cm (total length).

$$W = 0.00607 \cdot TL^{3.109} \quad M + F + \text{indetermined}$$

Where W is weight in g. and TL total length in cm.

4. REPRODUCTION

In November females have ovaries not far from complete maturity; spawning season occurs mainly in winter and it continues up to May.

Spawning area corresponds to the adults distribution area.

Probably sexual maturity is reached at the end of the first year of life, i.e. at a total length of about 20 cm.

Sex - ratio computed on samples collected in November shows a slight prevalence of the females: $M/F = 0.85$ $n = 260$.



Figure 1: Distribution and cpue (kg/h) of Merlangius merlangus (L) in May 1982.



Figure 2: Distribution and cpue (kg/h) of *Merlangius merlangus* (L) in November 1982.

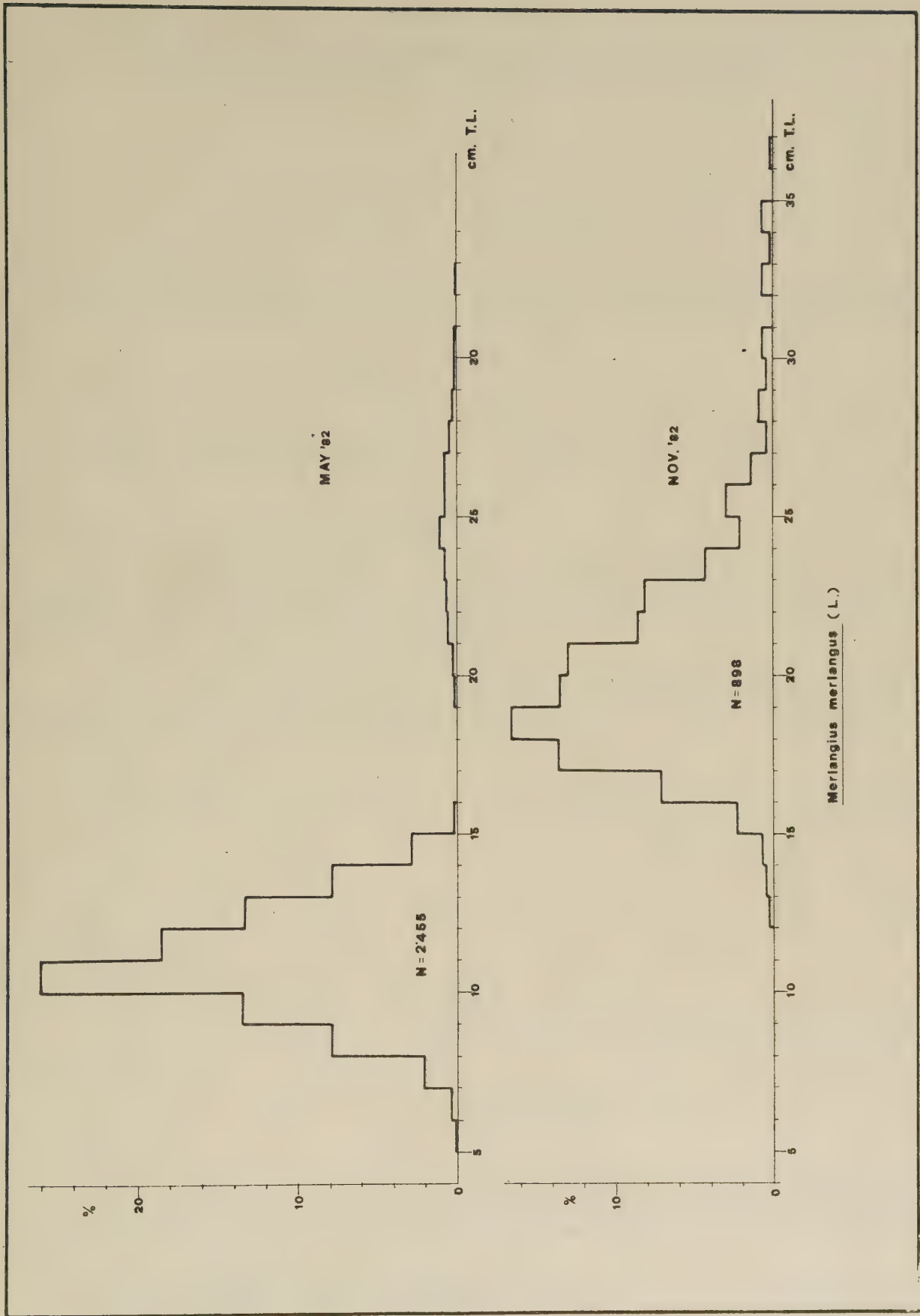


Figure 3: Size composition of the catches in May and November 1982.

ANNEXE V / APPENDIX V

Biological data collected during the Pipeta expeditions, on the poor cod,
Trisopterus minutus capellanus (Risso), in the Adriatic Sea

by

P. Tangerini and E. Arneri

Laboratorio di biologia marina e pesca - Fano, Italy

1. INTRODUCTION

In May and November 1982, two trawl surveys expeditions have been carried out in the Northern and Central Adriatic Sea by "Pipeta", a 300 HP trawler boat equipped with Italian type "tartana".

The collected data on the species are presented here.

2. DISTRIBUTION AND RELATIVE ABUNDANCE

The mean catch per hour values (kg/h) for each station and the presence (T = traces) of poor cod, are illustrated in figures 1 and 2. The species has been caught in the whole investigated area with the exception of the coastal waters.

It seems to be more frequent along the median part of the Adriatic. A bigger catch took place in November due to almost completed recruitment.

The size frequency distribution in the catch is reported in figure 3. It should be noted that the size of the fish caught is correlated to the selectivity of the net. In May the class 1 is predominant, while the year class 0 has a minor number of recruitments. In November the catches belong largely to the class 0. There are no significant concentration areas for juveniles and no elements to advance an hypothesis about migrations.

The total lengths are slightly lower in the southern part of the investigated area, than in the northern one. This could be due to a delaying of the spawning season, or to a low growth due to a lower environmental productivity. (The water gets cool later in the South, or the species, with a winter spawning period, reproduced later.).

3. GROWTH

Growth has been studied by reading the otoliths and the length frequency distribution:

	MALES			FEMALES		
Class	0	1	2	0	1	2
May	7.5	14.6	17.4	7.5	14.9	18.0
November	13.8	16.8	/	14.2	17.9	/

For the classes 0 and 1, the results agree with Frogliia (1981).

The length - weight relationship has been computed with the samples of the May expedition.

N = 563 from 6 to 24 cm.

W = 0.00498 $TL^{3.269}$ W = Weight in g.
TL = Total length in cm.

4. REPRODUCTION

The spawning season takes place in winter and in early spring until May. The females caught in November have ovaries that are getting mature. Only those with an age of 1 year are nearly mature. No particular areas of reproduction were found because females with ovaries in maturation are caught everywhere.

The sexual maturation is mostly reached at the end of the first year of life at a length of 13 cm. This is in accordance with Frogliia (1981). Only a small part of the females reach the sexual maturity in the second year of life. The total sex - ratio shows a prevalence of females.

M/F = 0.46 May N = 314
M/F = 0.31 November N = 552

5. MORTALITY

By using the catch curve method (Pauly 1983), the following values of the instantaneous coefficient of total mortality (Z) have been computed:

May	$Z = 1.00$
November	$Z = 0.99$

6. REFERENCES

- Frogia, C., Summary of biological parameters on Trisopterus minutus capellanus (Risso) in the 1981 Adriatic. FAO, Rapp. Pêches/FAO-Fish.Rep., (253):97-100.
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Figure 1: Mean catches (kg/h) in May. T = (traces).

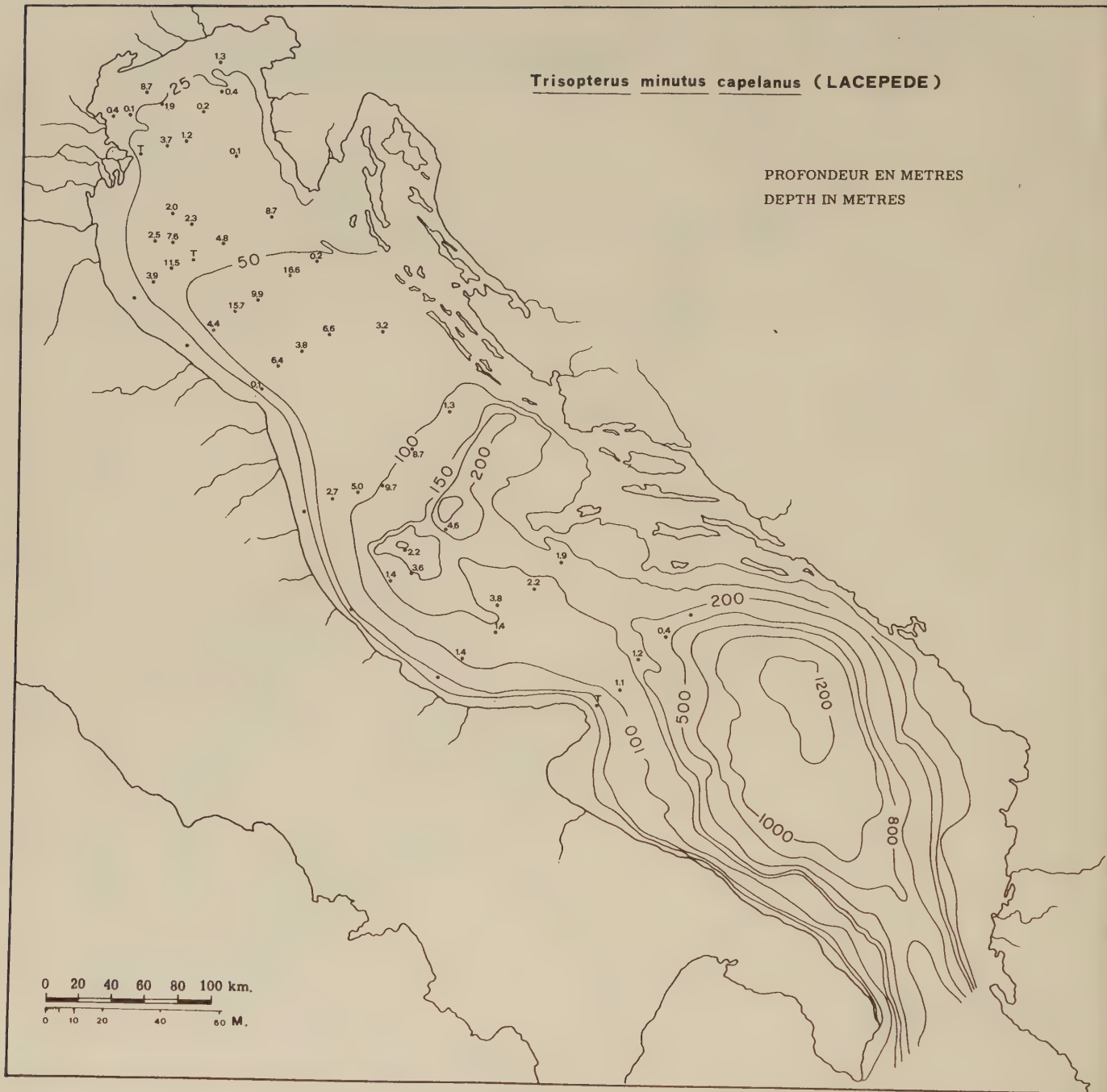


Figure 2: Mean catches (kg/h) in November.

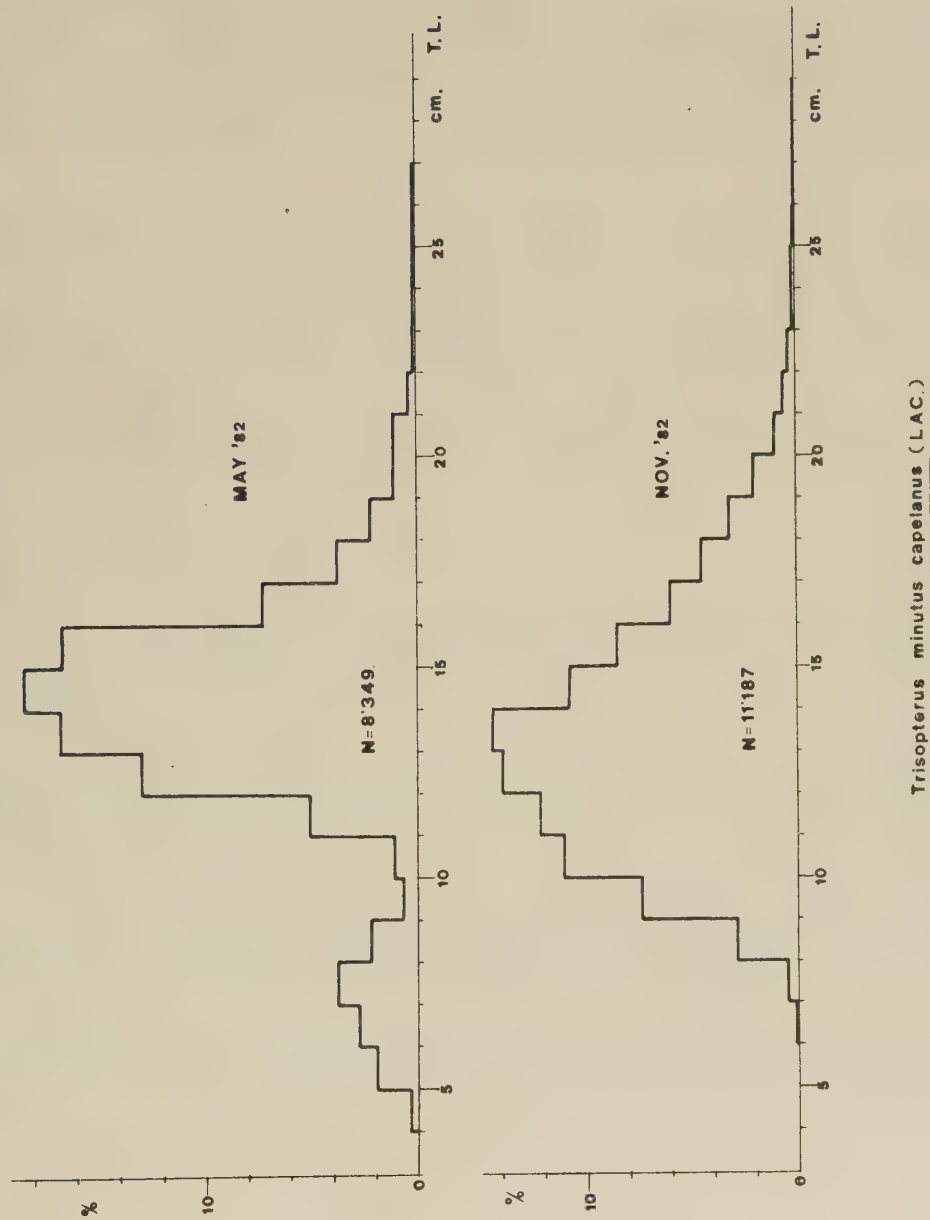


Figure 3: *Trisopterus minutus capellanus*. Size frequency distribution.

ANNEXE W / APPENDIX W

Biology and fishery aspects of the scaldfish
Arnoglossus laterna (Walbaum) 1792, in the Adriatic Sea

by

O. Giovanardi and C. Piccinetti
Laboratorio di Biologia Marina e Pesca - Fano, Italy

1. INTRODUCTION

The scaldfish, A. laterna (called "suacia" or "zanchetta" in Italian) is one of the most common and actively fished flatfish in the Italian seas. This small fish is characterised by eyes on the left side separated by a very narrow space or a bony crest. The body is covered with very decaying scales that are lightly ctenoid on the ocular side and cycloid on the blind side.

It is a benthic organism living on soft bottoms from a depth of a few meters to some hundred meters.

It is present in the eastern Atlantic from the Norwegian to the Moroccan coasts; in the Mediterranean, it is found as far as the Sea of Marmara.

Due to the variability of some characters such as number of vertebrae, mouth size, etc. many varieties or forms have been described, sometimes indicated as different species (A. laterna communis - biscayensis, microstoma - macrostoma, "pale" and "pigmented" larval types at different metamorphosis times (Kyle, 1913 in Padoa, 1956).

The species is caught mainly by means of Italian type trawls - "tartana" and "rapido"; it contributes with other less common scaldfish species and with the yellow - sole to form the so-called "frittura" on the local markets.

This work deals with data of monthly trawling operations carried out with the "rapido" of a professional Fano trawler.

The stations, located at 0.5, 1, 2 and 4 miles from the coast are the same as those described and utilized in the work on the yellow - sole, Solea lutea (Risso), (Giovanardi - Piccinetti, 1981). Catch rate per species, zone and position of the stations, bottom types, depth, biocenosis, water salinity and temperature on the bottom at the different distances from the coast have been shown in that work.

Out of 7,670 flat - fish specimens (eight species) caught in one year 43.17 per cent were A. laterna. Considering the relative proportions and the specific average weights of the specimens caught (8.7 g. in the case of A. laterna) we have found, for example, that the catch of A. laterna is six times superior in weight to that Solea vulgaris Quensel (a reference highly praised species) in the coastal zone.

A wider picture of the Adriatic stock comes from preliminary data of the fishery cruises carried out in May and November 1982 in the Northern and Central Adriatic by "Pipeta", a professional 300 H.P. fishing-boat from Fano equipped with a normal "tartana" of the Italian type (stations and CPUE are shown in Figure 1). The figures show the ubiquity of A. laterna.

As in the case of S. lutea we stress the unneglected economic importance of these two "small" fish that constitute a fundamental part of the income of all trawlers, especially the small ones.

The size frequency distribution is represented in Figure 3; it does not show significant differences in relation to the different distances from the coast while in some histograms the classes can be recognized.

5. MORTALITY

By means of the growth parameters and of the mean annual water temperature on the bottom we have calculated the instantaneous coefficient of natural mortality $M = 0.57$ (Pauly method, 1980). The value is in accordance to that given by the relation between maximum age and natural mortality (Tanaka in Alverson, 1971).

An estimation of the instantaneous coefficient of total mortality Z has been calculated by the catch curve assuming a constant recruitment and using only 2 and 3 age - classes obtaining $Z = 1.49$ (coastal zone by "rapido").

By means of the formula $Z = K (L_{\infty} - \bar{L}) / (\bar{L} - L_c)$ where L is the mean capture size and L_c is the mean first capture size we have obtained $Z = 1.43$. (the whole Northern and Central Adriatic by "tartana").

6. GENERAL CONSIDERATIONS

Although the above data are preliminary we can make some general considerations.

It has been stated in the previous note on *S. lutea* how different the selectivity between "rapido" and "tartana" is, the latter being less selective. However, considering both the size at first capture in the case of the November 1982 cruise with "tartana" and histograms in Figure 3, with "rapidi" in the coastal zone, we can say that only a small part of the landings has not spawn yet since almost exclusively over one year old specimens were caught. This is one of the reasons for the constancy and the relative importance of the catch level in time.

The common use of about 20-25 mm mesh size cod - end could be acceptable in the case of this species since a regular mesh (more than 40 mm) lets the bigger part of the catch escape. According to Ferretti and Froglia (1975) in the case of "rapido" with knotless polyamide cod-end, with mean mesh size of 41.5-41.6 mm. the selection factor is equal to 2.4-2.7 with a 50 per cent retention length equal to 10.0-11.1 cm.

Concerning fishing within 3 miles from the coast which is forbidden during some months or the whole year in many maritime compartments in the Adriatic sea, we have a situation similar to that described in the case of the yellow-sole; we can affirm that the coastal fishing activity, (specifically on the sculdfish, does not seem to show either overfishing or catch which is under critical size, at least in the zone and for the years considered here.

With reference to the aforementioned mortality values we have the instantaneous coefficient of fishing mortality F which is slightly superior to M ; if $F > M$, it really means that the level of fishing might be excessive. On the other hand similar cases are found for atherinids and gobids characterized by very short life cycles.

All these species form the basic income for all the small trawlers and undoubtedly the present law limitations are harmful both to small fishing operators and to correct management of these stocks.

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1964 Arch.Oceanogr.Limnol., 13(2)

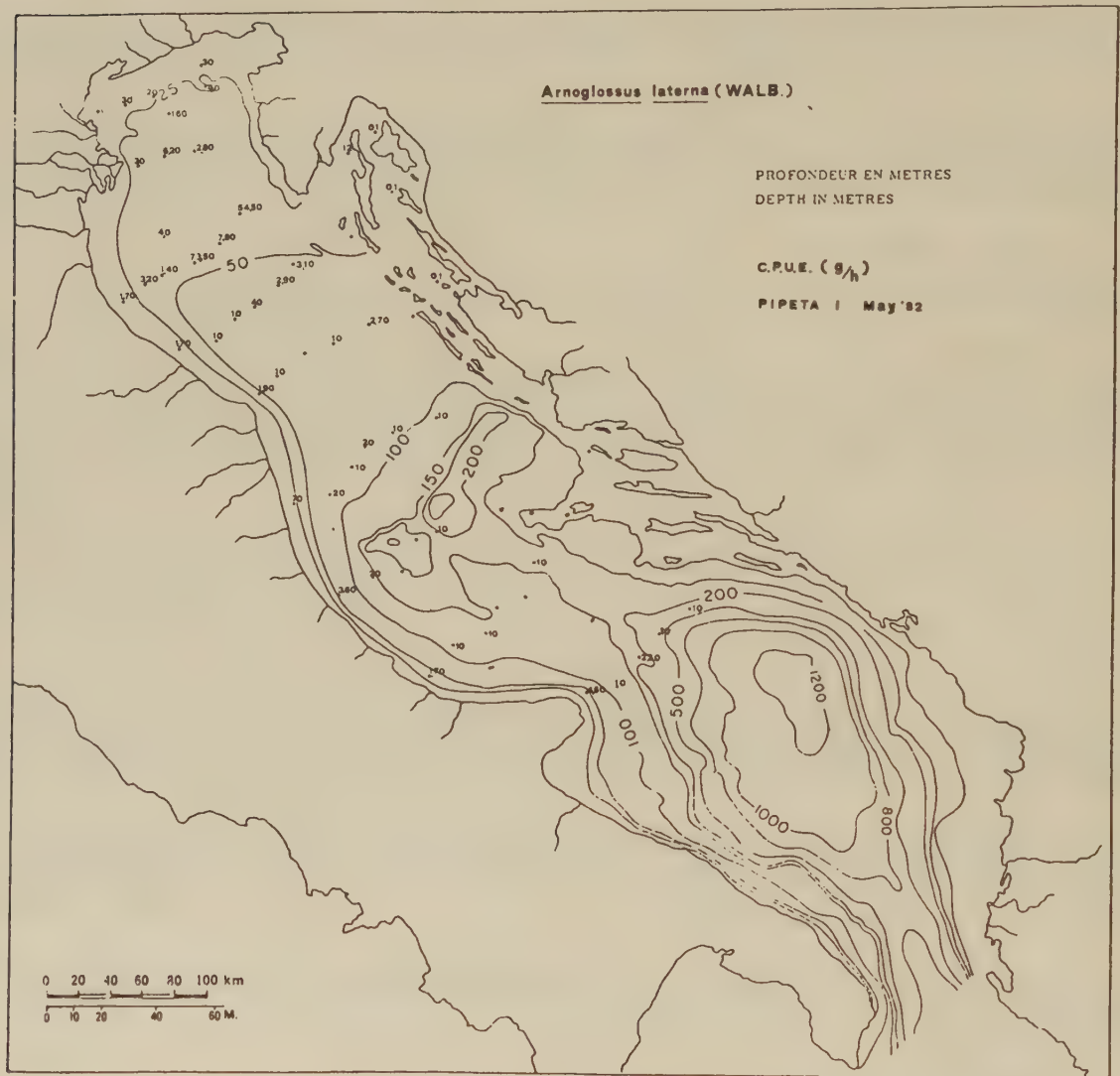


Figure 1 - Cruise "Pipeta I" - (May 1982) - Stations and CPUE (g/h).

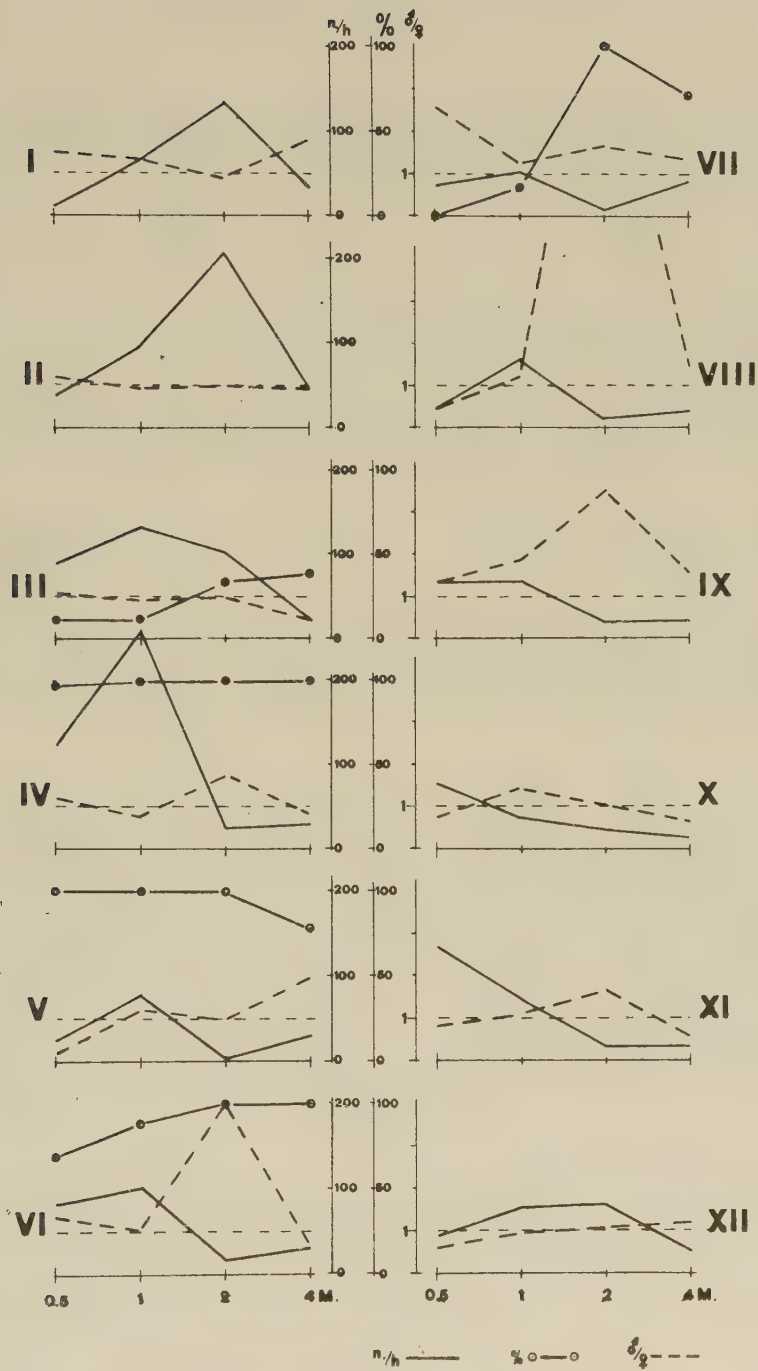


Figure 2 - Monthly values, at different distances from the coast of Fano for :

- capture (n/h specimens/h/2 "rapidi" trawls in nb/h.
- rate of sexually mature females in %.
- sex-ratio ($\delta/\text{♀}$)

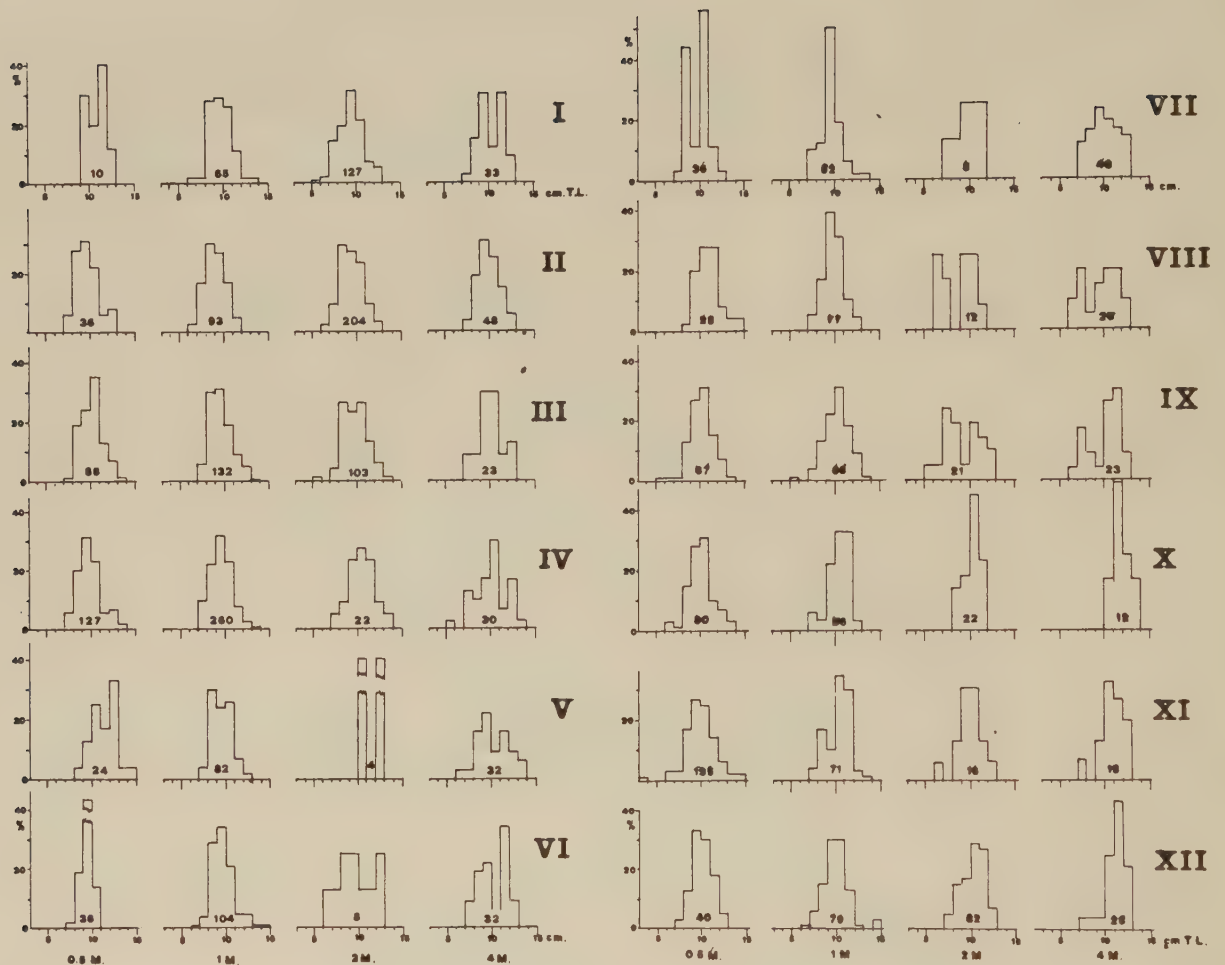


Figure 3 - Monthly size frequency distributions at different distances from the coast.

ANNEXE X / APPENDIX X

A note on the biology and fishery of the black goby (*Gobius niger*) in the Adriatic Sea

by

Gianna Fabi and Carlo Froglia
Istituto Ricerche Pesca Marittima, (C.N.R.) - Ancona, Italy

1. DISTRIBUTION

The black goby (*Gobius niger*) is a small benthic fish very common on sandy and muddy bottoms (depths 5-50 m) of the western Adriatic. During the spawning season it crowds on infralittoral coastal sands, whereas in the other periods of the year it is dispersed on circalittoral coastal terrigenous muds.

2. REPRODUCTION

G. niger is a dioecious species; the female spawns once per year and benthic eggs are laid in a primitive nest (empty shells, stones, artificial substrata) and watched by the male.

The spawning season extends from April to August (Fig. 1). The sexual maturity is reached at the end of the first year of life. In the spawning season 50% maturity was estimated at 8.5 cm and 7.5 cm (T.L.) for males and females, respectively. The smallest mature male and female had a total length of 6 cm.

Adult males and females can be recognized by the relative development of dorsal fins and the overall colour pattern.

Sex-ratio was found to be close to 1 during the spawning season whereas, in samples collected in other periods of the year, males considerably outnumbered females (Fig. 2). Black goby is known to dig into sediments and to make use of empty burrows of other species; seasonal differences in catchability of the two sexes can be the result of their different concealment behaviour.

3. GROWTH

Males reach a bigger size than females (Fig. 3) probably as a consequence of a different growth rate. Maximum sizes (total length) observed are 16 cm for males and 14 cm for females. Petersen's method was applied to monthly size frequency distributions obtained in 1977 through sampling off the Po River Delta with a small mesh bottom trawl. Juveniles of the 0⁺ age class appeared in September catches; their T.L. was about 4 cm; no significant growth was observed in winter months; at the end of May their average size was about 6.5 cm. The long spawning season and the different growth rate of the two sexes make Petersen's method unsuitable to study growth of adults.

Length-weight relationships were computed as follows, as G.M. functional regression, separately for males, females and juveniles (T.L. less than 7 cm) from samples collected in different periods of the year off Po Delta and Ancona.

Males	$W = 0.00882 \cdot TL^{3.12}$	($r = 0.96$ $n = 1474$)
Females	$W = 0.02211 \cdot TL^{2.73}$	($r = 0.84$ $n = 875$)
Juveniles	$W = 0.01084 \cdot TL^{3.02}$	($r = 0.96$ $n = 274$)

where W is weight in grammes and TL is total length in centimeters.

4. FEEDING AND PREDATORS

Benthic species predominate in diet of G. niger; Amphipods, Tanaids and small Decapods, together with Polychaetes worms are the most abundant preys observed.

In the investigated area of the central Adriatic, G. niger was found to be a preferential prey of adult gurnards (Trigla lucerna) and was occasionally found also in gut contents of Psetta maxima, Scophthalmus rhombus, Merluccius merluccius and Lithognathus mormyrus.

5. PARASITISM

Material collected off Ancona was heavily infected by the Acanthocephalid worm Acanthocephaloides incrassatus. Nematodes were rarely observed; the following species Thynnascaris aduncum, T. clavatum and T. fabri were already reported in G. niger from the Adriatic sea.

6. FISHERY

Landings of this species derive from the activity of bottom trawlers working mainly in the coastal area; during the spawning season small catches are also obtained with pots. No national statistics are produced for G. niger, but it is recorded separately in some Italian fish markets. From these records, it appears that this low-priced fish makes up over 10 per cent of the total production of demersal fish. Landings show two maxima (Fig. 4): the first one in coincidence with the spawning concentration of adults in coastal areas (April, May) and the second in autumn when adults leave the cooler coastal areas and move towards circalittoral muds.

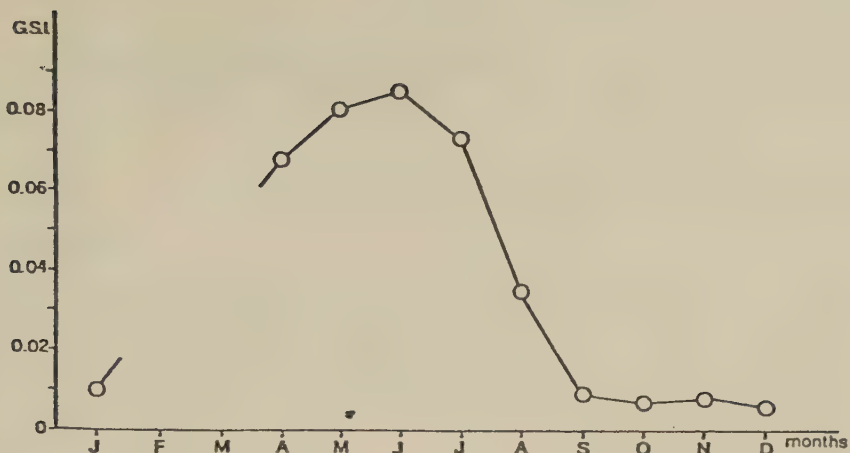


FIGURE 1 - Monthly variations of gonosomatic index (GSI) in females of *G. niger* collected off Ancona (depth 10-15 m). Spawning season extends from April to August.

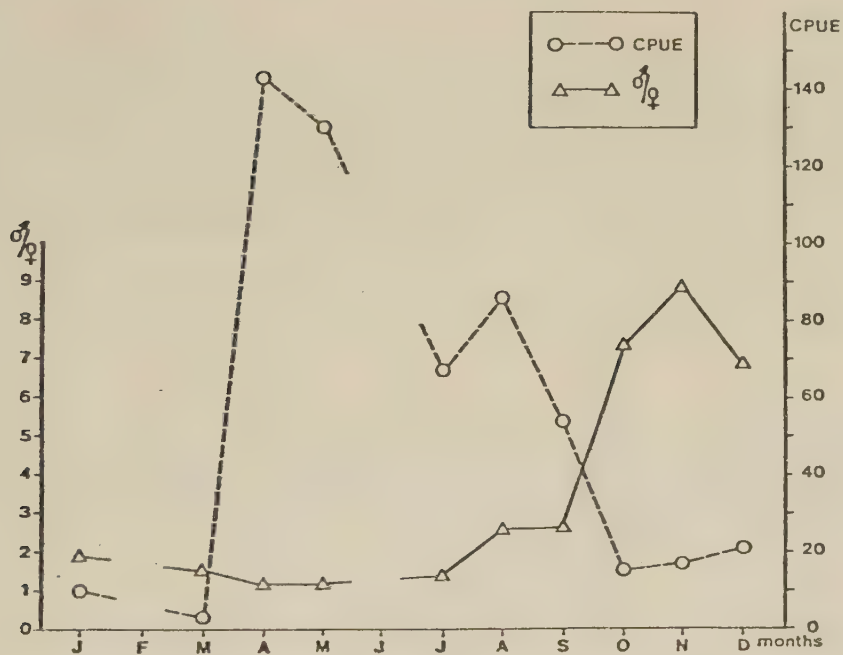


FIGURE 2 - Monthly variations of CPUE (number of fish per hour trawling with 2 "rapido" (beam-trawl) of 1.6 m) and sex-ratio obtained in samples of *G. niger* collected monthly off Ancona. Sex-ratio tends to 1 during spawning season when also maxima of CPUE are recorded.

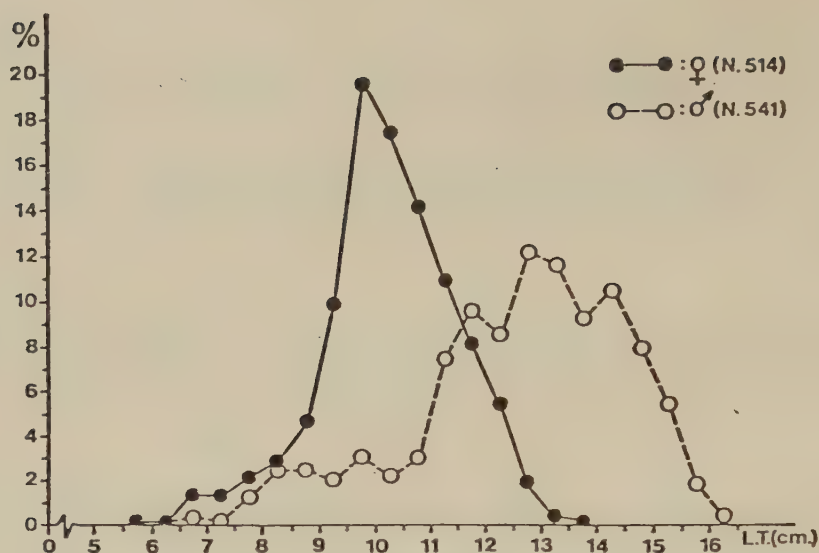


FIGURE 3 - Size frequency distributions of males and females of *G. niger* collected during the spawning season off Ancona with the "rapido" (cod-end meshes 26 mm opening)

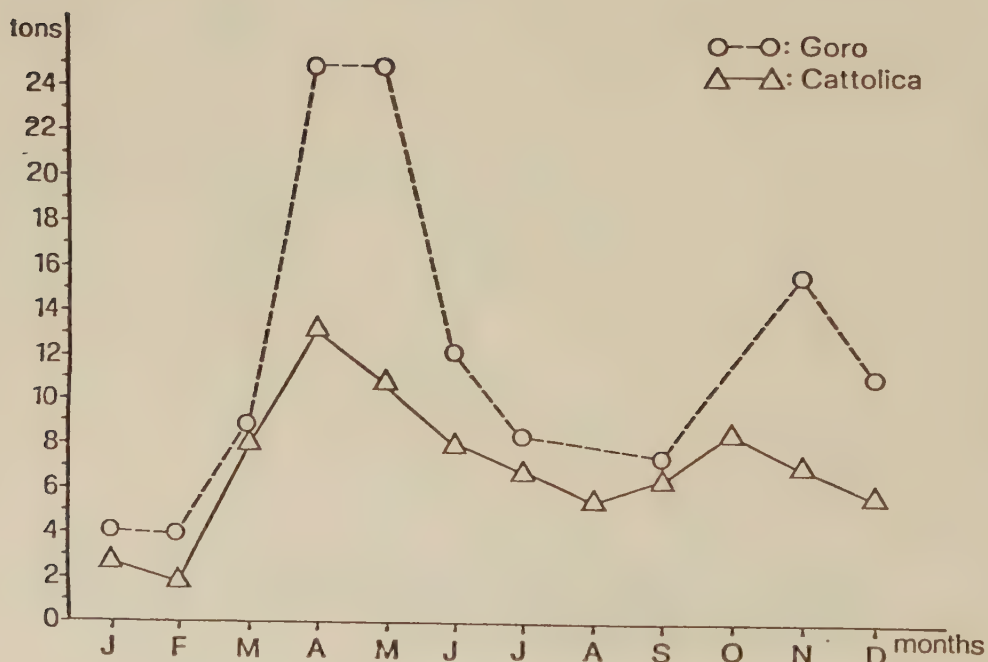


FIGURE 4 - Monthly landings of *G. niger* for the fish market of Goro and Cattolica (average for the years 1981-82)

ANNEXE Y / APPENDIX Y

Résumé des paramètres biologiques sur Venus gallina L. en Adriatique

par

Patrizia Casali

Laboratorio di Biologia Marina e Pesca - Fano, Italie

1. DISTRIBUTION

Venus gallina est répandu en Adriatique sur une étroite bande côtière le long des côtes italiennes à partir de Punta Tagliamento jusqu'au promontoire du Gargano; il y a des zones de présence limitées au sud de Manfredonia. L'ampleur de la zone de distribution varie entre 1000 et 4000 mètres de la côte et est limitée vers le large par l'isobathe 12-15 mètres. Ce mollusque caractérise la biocénose des sables fins côtiers et est associé quelquefois à l'annélide Owenia fusiformis (Fig. 1).

2. CROISSANCE

Les études réalisées sur l'espèce, ont déterminé la courbe de croissance (Fig. 2 d'après Frogia, 1975).

Il existe une certaine variabilité dans la croissance en fonction des mois de naissance. La relation taille-poids est la suivante: $P = 0,29 l^3$ où la taille est exprimée en centimètres et le poids en grammes.

3. REPRODUCTION

La taille à la première maturité sexuelle est entre 10 et 11 mm. La fécondité varie en fonction de la taille et est très faible dans les individus de 10-11 mm; seulement après 20 mm le nombre d'oeufs produit est élevé. La période de ponte s'étend entre avril et octobre. Les larves arrivent sur le fond pendant une période très étendue et l'étude de l'arrivée des jeunes sur le fond, réalisée par le Laboratoire de Fano pendant trois ans, montre que la période de descente intense est très variable; par exemple, en 1978, la fixation s'est réalisée presque totalement en novembre tandis qu'en 1979 elle était en mai.

Différents auteurs (Guérin, 1973, Frogia, 1975) et nos données confirment que la descente au fond des larves est variable pendant une année et il ne s'agit pas d'un phénomène particulier.

4. MORTALITE

Une longue série de prélèvements quantitatifs, réalisés avec une benne pour éliminer le facteur sélectivité, permet de calculer la mortalité séparément par classe d'âge et en total pour une cohorte. Le tableau montre les valeurs de mortalité instantanée pour différentes périodes :

Age	26/6/80		15/9/80		25/11/80		24/4/81		27/9/82		5/1/83	
	n/m2	Z	n/m2	Z	n/m2	Z	n/m2	Z	n/m2	Z	n/m2	Z
0 ⁺	1,9		54,5		106,5				18,8			
1 ⁺	1274,8	0,25	1204,2	2,67	724,6	0,61	161,5	1,22	228,6	1,09	111,7	
2 ⁺	215,7	4,61	78,2	4,30	34,5	4,07	562,0	4,70	28,2	3,13	170,3	
3 ⁺	6,9	3,63	3,1	1,13	2,5		6,5		0,7		12,1	

Tableau 1: Valeurs de densité n/m2 et de mortalité instantanée pour différentes périodes.

La mortalité totale est très différente d'une classe d'âge à l'autre - par exemple la mortalité de la classe 1⁺ est en moyenne sur trois ans de 0,97; sur la classe d'âge 2⁺ elle est de 3,96. Cette différence peut être expliquée par une plus grande mortalité par pêche sur la classe 2⁺ qui s'ajoute à la mortalité naturelle.

5. PECHE ET AMENAGEMENT

La capture totale en Adriatique varie entre 80.000 et 120.000 tonnes par an et est exercée par presque 500 bateaux avec dragues. Sur la base de la courbe de croissance et la courbe de mortalité, on obtient que le poids maximum de chaque cohorte se situe à l'âge de 1 an à la taille de 15,8 mm.

Sans une variation de la mortalité actuelle, on obtiendrait une capture plus abondante quantitativement avec cette taille moyenne de capture.

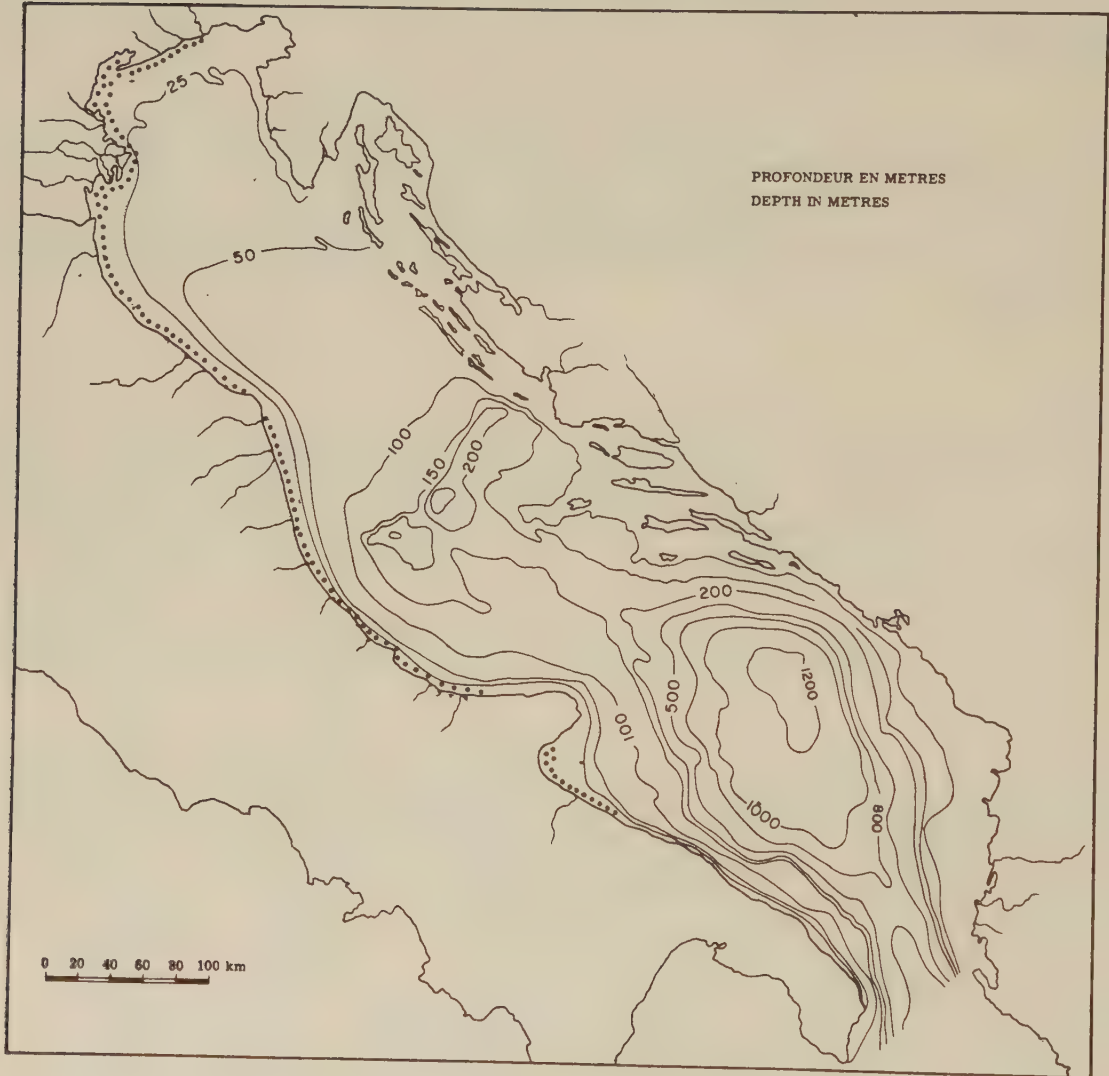


Figure 1 - Distribution de Venus gallina dans l'Adriatique italienne.

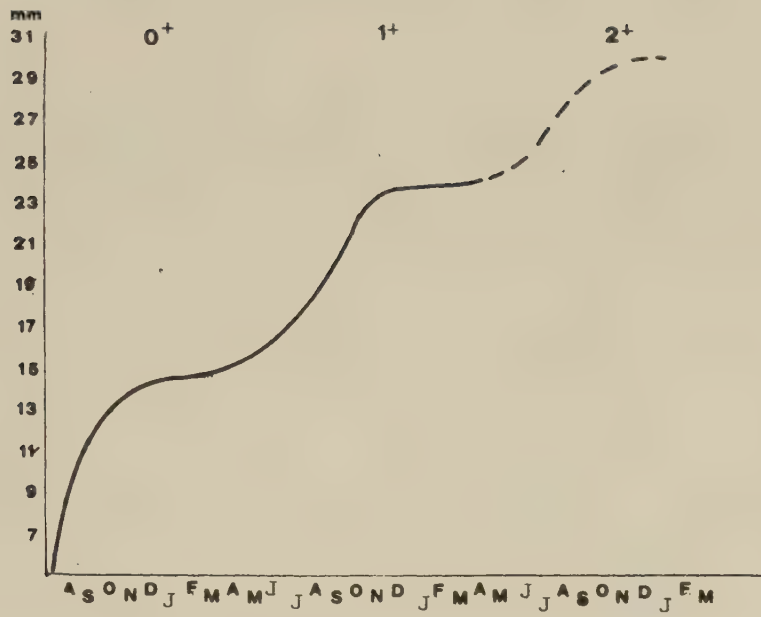


Figure 2 - Courbe de croissance de Venus gallina.

ANNEXE Z / APPENDIX Z

Progress Report on the PESTAT programme:
A sample survey system for the quality check of fisheries statistics

by
1 2 3
J. Mortera, D. Levi, N. Cingolani

with the collaboration of 3
G. Giannetti, R. Scorcelletti, E. Peloni and N. Frontini

1. INTRODUCTION

The Central Statistical Institute (ISTAT) provides Italian official statistics on composition and characteristics of fishing vessels and level of production of the fishing industry. The system they adopt for data collection has not substantially changed since 1959. It is based on the reporting approach and no checking is done in the field. This official statistics is lacking in many important characteristics: catch is not allocated by type of fishery and statistical division, fishing effort, the localization pattern of fishing activity by type of fishery and migratory and seasonal patterns are not given.

Thus IRPEM, CNR, Ancona launched on a grant from the Ministry of Merchant Marine (MMM) and in collaboration with the Fisheries Department of FAO, a quality check national statistical survey on the existing fisheries statistics, called PESTAT programme.

The objective of the programme was twofold (see diagramme 1):

(a) A Quality Check Frame Survey (QCFS) was designed to give detailed information on the present structure, dimension and localization pattern of the primary fishing industry. This survey was designed and executed in 1980. It has provided the data necessary for making an accurate evaluation of the present size and organic structure of the primary fishing industry, the correction factors for updating statistical time series, the critical analysis of existing data on marine fisheries and the frame for selecting the sample of sites with stratified probability proportional to size (PPS) for the catch and effort sample survey. For gathering the necessary items of information on the existing Italian fleet, two approaches were adopted:

(1) Listing Frame Survey: This survey was used to list in a systematic way the items of information contained in the local registries of fishing vessels using the census approach (29741 questionnaires).

(2) Area Frame Sample Survey: This survey was used for the collection of the required information on the existing fishing units at the selected sites using stratified PPS selection criterion (10192 questionnaires for the motorised and mechanised vessels/ 7995 for the non-motorised).

(b) A Quality Check Catch and Effort Sample Survey (QCESS) designed to provide reliable estimates on a monthly basis of fishing catch and effort data on a sectorial/gear basis as well as the mobility pattern of the fishing units and the pressure exerted by them on the exploited fishing grounds (see diagramme 2).

The following groups collaborated in the realisation of the programme:

- one IRPEM division;
- 12 cooperatives and/or coordinators on CNR contracts;
- 45 young people recruited from the unemployment lists (law n. 285).

1 IRPEM research contract; now Department of Statistics, Probability and Applied Statistics, Rome University.

2 IRPEM, C.N.R., Ancona, now Director ITTPP CNR, Mazara del Vallo.

3 IRPEM, C.N.R., Ancona.

2. QUALITY CHECK OF THE FRAME SURVEY DATA

The quality of data produced on large-scale statistical surveys is of fundamental importance. Many sources of error are inherent in this type of survey. They may be divided into two types:

- (a) sampling errors of the sampling process which are measurable and whose magnitude depends among other things, on the size of the sample;
- (b) systematic errors or bias. The latter can be due to:
 - (i) programming of the survey i.e. definitions of the characteristics to be measured not clearly given;
 - (ii) design of the process i.e. sampling from incomplete frames, applying biased estimation procedures, etc.;
 - (iii) errors committed in data collection. These can be subdivided into coverage and content errors such as omissions, erroneous inclusions and reporting errors;
 - (iv) errors in data processing due to editing, coding, punching and tabulation.

The sampling error or precision of the sampling scheme is measurable, whereas the other errors are often not detectable and will seriously jeopardize the quality of the results. Quality check programmes can be used for assessing the magnitude and direction of systematic error.

In our case programming and designing was accurately executed. Two training courses were held, detailed manuals were prepared with clear definitions of the population characteristics to be measured; pilot studies were performed and each recorder was given regular supervision throughout his work. FAO international definitions and concepts were used where possible.

Data collection and processing errors were studied in great detail and the following methodology was used to eliminate them where possible:

- (a) precodified data was sent to IRPEM where manual checking was made and detected errors corrected;
- (b) the data was then transferred on magnetic tapes using automatic data debugging with traps and filters (e.g. code testing, tests on maximum and minimum values, logical traps, tests on ratios between related quantitative characteristics). Lists of these errors found through automatic data entry were prepared. These were compared to the original documents and corrected where possible. The type of error detected was codified and quantitative analysis of the sources of these errors was made (e.g. errors due to recording, input errors, errors due to original documents). The analysis of the latter will contribute to the evaluation of the quality of the official registries.
- (c) listing frame and area frame tapes, having the same codification keys were matched vessel by vessel and coverage errors eliminated by exchanging parameters for the "matched vessel" between the two surveys. This procedure was also used to check the quality of official registries by analysing the discrepancies between the matched data.
- (d) the remaining coverage errors were eliminated by using estimates found from multiple regression analysis between interrelated characteristics, e.g. HP, GRT, length, etc. The process used to find these estimates was as follows: first the items (vessels) were divided into two sub-populations, those with and those without missing data. The vessels were then stratified by type and by size of parameters. Multiple regression was performed within each vessel type/size domain. The validity of the estimated models was tested by comparing the regression coefficients between the two sub-populations and testing the "null hypothesis".

Most of the coverage and content errors were eliminated using the process given above.

The data of the Frame Survey on national primary fishing industry codified on magnetic tapes will be adopted by ISTAT, the MMM and EUROSTAT. Results of the Frame Survey will be published shortly, in a series of volumes giving the methodology used and the tables of statistical data on the primary fishing industry. At a later stage a series of volumes will be produced providing the methodology and calculated estimates of the catch and effort survey.

3. FUTURE PROSPECTS

The future prospects of this programme can be summarized as follows:

- (a) The input, editing, analysis and publication of catch and effort statistics. These will begin if the necessary financial support is allocated to the PESTAT programme by Law 41 of 17.2.82. The GFCM resource evaluation working party is interested in these data since they adhere to all the FAO criteria. They will also be useful for the economic appraisal of the status of the fishing industry and for the stock management scheme which should form part of the three year plan which Law 41 must provide.
- (b) A preliminary phase will be programmed for exchanging the know-how of the system from IRPEM to MMM.
- (c) The MMM will be employing 60 statistical recorders distributed among the Central Organisation, the Maritime Sections and the "Capitanerie" (art. 5 L.41).
- (d) To accomplish (b) and (c) the Frame data must be continually updated with exchange of information between the "Capitanerie" and MMM.
- (e) These projects will be discussed when the PESTAT report will be published, at the working group on the reform of fisheries statistics organized by ISTAT.

For the importance of high quality fishery statistics at a national and international level, we stress the necessity that all the experience gathered during this project and all the funds engaged become fully utilized by the institutionalization of this statistical system. It would be a great pity if the data collected till now should grow out of date.

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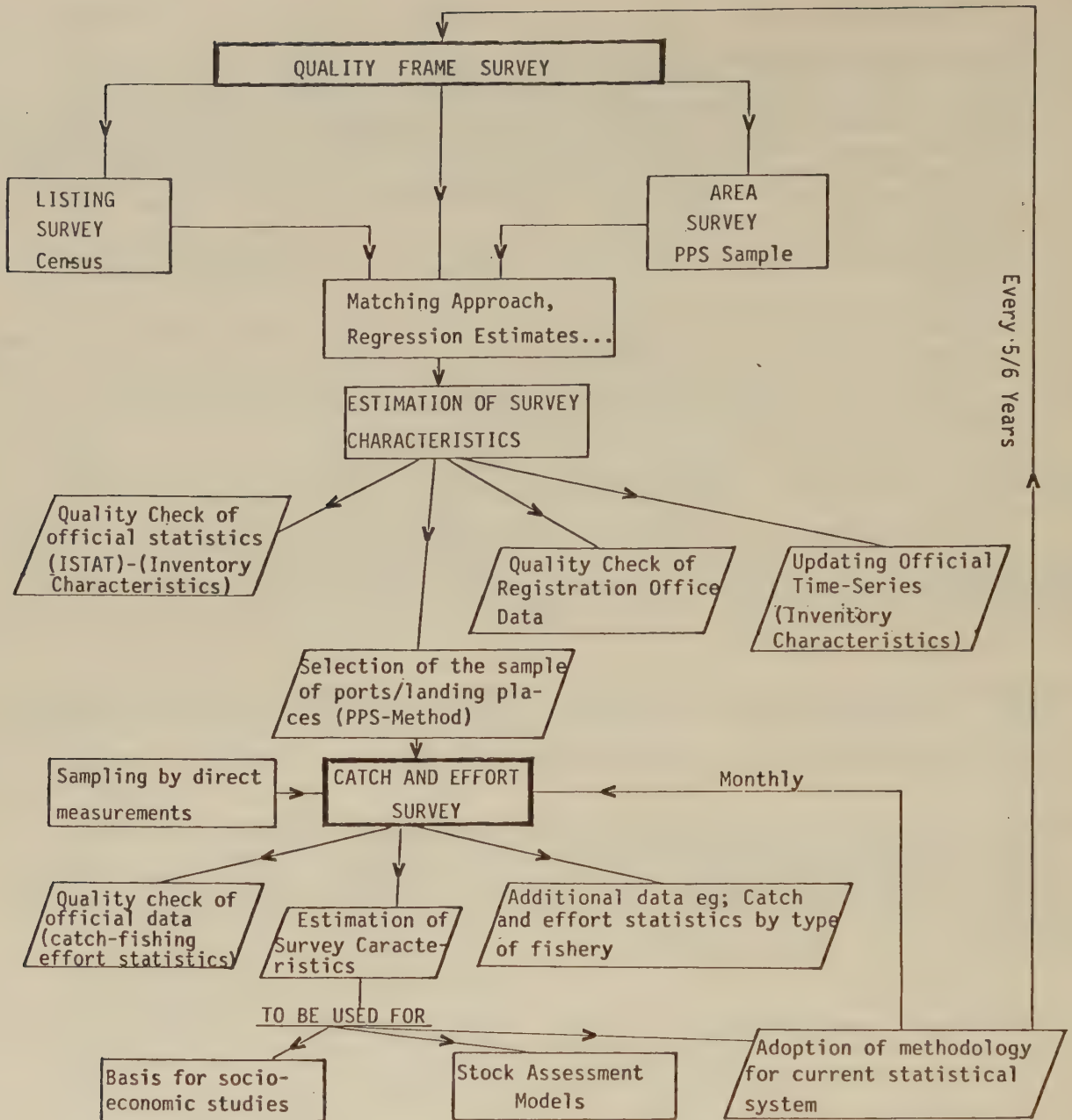


DIAGRAM 1 - QUALITY CHECK SURVEY SYSTEM ON FISHERIES STATISTICS

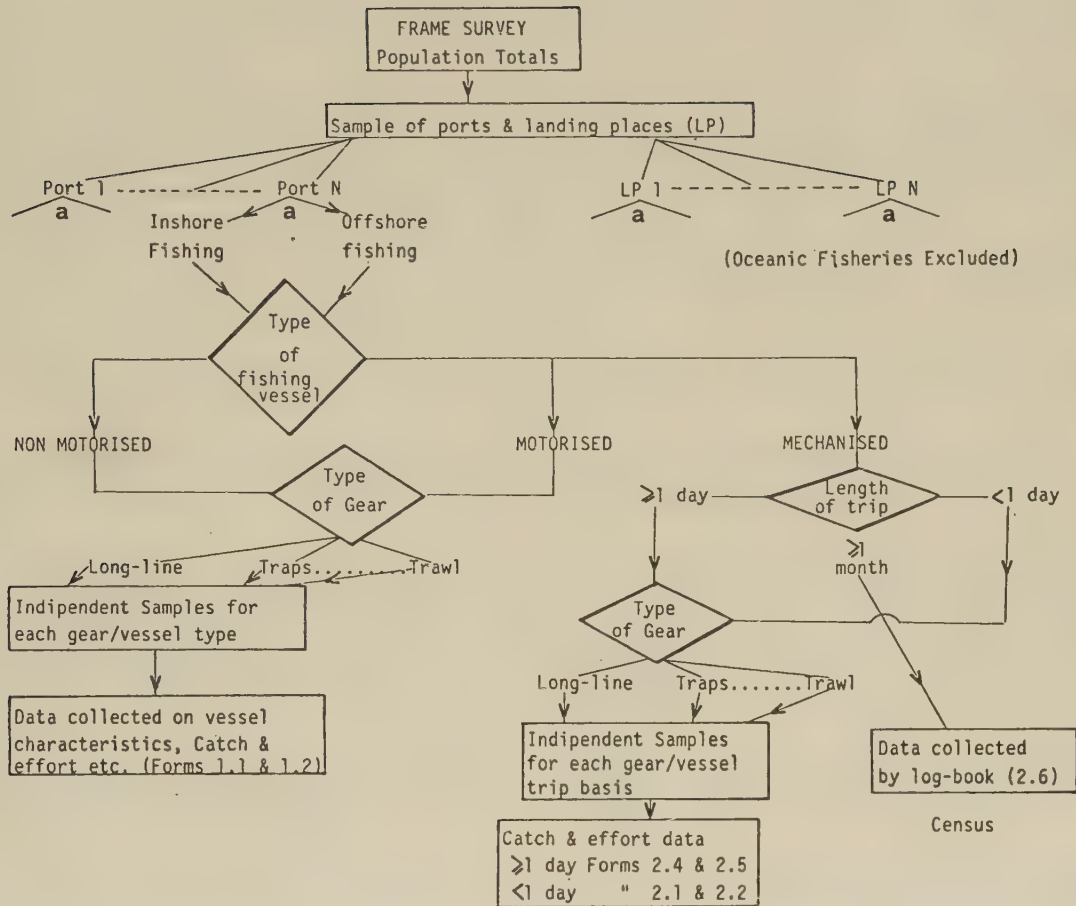


DIAGRAM 2 - CATCH AND EFFORT QUALITY CHECK SAMPLE SURVEY
SAMPLING IN SPACE - Stratification levels

ANNEXE AA / APPENDIX AA

Considérations sur les premiers résultats de la campagne de chalutage Pipeta

par

C. Piccinetti et S. Jukić**

* Laboratoire de biologie marine et pêche - Fano, Italie

** Institut d'océanographie et pêche - Split, Yougoslavie

Au cours de l'année 1982 le Laboratoire de biologie marine et de pêche de Fano et l'Institut d'océanographie et de pêche de Split, ont réalisé deux campagnes de chalutage avec le bateau de pêche commercial "Pipeta".

Chaque campagne, réalisée à des saisons différentes, mai et novembre, a couvert 50 stations différentes distribuées sur toute l'Adriatique de Trieste jusqu'à la ligne promontoire du Gargano - Kotor. Les stations ont été choisies sur la base des cartes de distribution des biocénoses et de la profondeur, de façon à avoir au moins une station sur chaque biocénose. Le nombre des stations a été plus élevé dans les zones où il y a une pêche traditionnellement plus intense.

Sur toutes les stations on a fait trois heures de chalutage; on a mesuré la stratification de la température et de la salinité, pris des échantillons du sédiment, du benthos et de l'épifaune pour étudier d'éventuelles corrélations avec la pêche.

La figure 1 présente le rendement horaire moyen en kg pour chaque station pendant la campagne de mai et la figure 2 les rendements moyens de novembre.

Il est possible de noter une variabilité très haute du rendement horaire au cours de la même campagne et une différence très évidente dans les rendements entre les deux campagnes; en novembre, les rendements sont toujours plus élevés (en moyenne 25,78 kg/h en mai et 30,86 kg/h en novembre).

La composition spécifique des captures a été précisée, station par station; il est évident qu'un nombre très élevé d'espèces sont capturées dans la même zone; en plus il y a une différence dans la composition en espèces d'une zone à l'autre. Si l'on compare la composition des captures au cours des deux campagnes, on peut observer que l'importance pondérale et économique de chaque espèce dans la même station change avec la saison; cela est dû principalement aux différents cycles biologiques et à l'importance du recrutement dans les captures.

Sur un total de plus de 80 espèces capturées, les espèces les plus importantes sur le plan économique sont 37. Le tableau 1 indique pour ces espèces, le rendement moyen par heure sur toute l'Adriatique étudiée et, en pourcentage, l'importance sur le total des captures (moyenne horaire au cours de la campagne de novembre).

Si on regarde la composition par âge des captures, en partie présentée sur les documents espèce par espèce, il est possible de noter la grande importance dans les captures des classes 0 et 1.

En novembre, plus de 50 pour cent des captures pour les espèces les plus importantes sont constitués par des exemplaires de la classe 0 et 30 pour cent de la classe 1; cette situation explique la relation étroite entre les résultats de la pêche et le recrutement de chaque espèce et les fluctuations très grandes des captures qu'on a enregistrées ces dernières années pour quelques espèces (Sepia officinalis, Mullus barbatus, etc.).

Cette situation générale nous amène à considérer d'une façon différente la validité des modèles de production pour l'aménagement des ressources de l'Adriatique.

Un autre problème que les données sur la répartition par taille et la composition des captures nous permettent d'aborder d'une façon quantitative est l'effet d'une variation des mailles sur les captures.

Les données obtenues au cours des campagnes sur la distribution et l'abondance de chaque espèce sur la répartition par taille sur les aspects biologiques, comme l'on peut voir des données présentées à la réunion de Fano, sont d'un intérêt certain; en faisant les campagnes pendant quelques années de suite il sera possible d'avoir une série complète des données qui permettra d'avoir tous les éléments pour l'aménagement biologique des ressources de l'Adriatique.

Après les deux campagnes réalisées, une troisième vient de commencer dans les eaux territoriales yougoslaves.

Les résultats de ces recherches sont, pour l'extension géographique et pour la richesse d'informations recueillies, de la même importance que ceux de l'expédition "Hvar", avec la différence toutefois que les campagnes "Pipeta" sont étendues sur une zone plus vaste et répétées dans le temps pour donner une vision dynamique des phénomènes.

Le potentiel de recherche offert par une étroite collaboration entre les laboratoires de Fano et de Split permet d'obtenir et d'élaborer rapidement les résultats; à notre avis c'est un exemple qu'il conviendrait de développer.

TABLEAU 1

RENDEMENTS MOYENS - NOVEMBRE 1982

	KG/H	%
<i>Squilla mantis</i> L.	0,83	2,7
<i>Penaeus kerathurus</i> (Forsk.)	0,02	0,1
<i>Nephrops norvegicus</i> (L.)	0,28	0,9
<i>Loligo vulgaris</i> Lam	0,41	1,3
<i>Alloteuthis media</i> (L.)	0,14	0,4
<i>Sepia officinalis</i> L.	0,99	3,2
<i>Sepia elegans</i> d'Orbigny	0,20	0,6
<i>Eledone moschata</i> (Lam)	5,17	16,7
<i>Scylliorhinus canicula</i> (L.)	0,34	1,1
<i>Mustelus asterias</i> Cloquet	0,22	0,7
<i>Squalus acanthias</i> L.	0,54	1,7
<i>Raja clavata</i> L.	0,30	1,0
<i>Conger conger</i> (L.)	0,25	0,8
<i>Merluccius merluccius</i> (L.)	1,55	5,0
<i>Merlangius merlangus</i> (L.)	0,68	2,2
<i>Trisopterus minutus capellanus</i> (Lac.)	3,35	10,9
<i>Zeus faber</i> L.	0,10	0,3
<i>Trachurus trachurus</i> (L.)	0,88	2,8
<i>Trachurus mediterraneus</i> (Steind.)	2,02	6,6
<i>Mullus barbatus</i> L.	3,52	11,4
<i>Pagellus erythrinus</i> (L.)	0,55	1,8
<i>Trachinus draco</i> L.	0,11	0,4
<i>Uranoscopus scaber</i> L.	0,05	0,1
<i>Gobius niger</i> L.	0,94	3,0
<i>Scorpaena scrofa</i> L.	0,08	0,2
<i>Trigla lyra</i> L.	0,09	0,3
<i>Trigla lucerna</i> L.	0,10	0,3
<i>Eutrigla gurnardus</i> (L.)	0,10	0,3
<i>Citharus macrolepidotus</i> (Bloch)	0,03	0,1
<i>Lepidorhombus</i> sp.	0,07	0,2
<i>Arnoglossus laterna</i> (Walbaum)	0,08	0,3
<i>Soela vulgaris</i> Quensel	0,08	0,2
<i>Buglossidium luteum</i> (Risso)	0,05	0,2
<i>Microchirus variegatus</i> (Donovan)	0,28	0,9
<i>Lophius piscatorius</i> L.	0,44	1,4
<i>Lophius budegassa</i> Spinola	0,15	0,5
TOTAL	24,99	80,6
Autres espèces	5,87	19,4



Figure 1: Rendements horaires moyens (en kg) - Campagne "Pipeta" - Mai 1982.



Figure 2: Rendements horaires moyens (en kg). Campagne "Pipeta"-Novembre 1982.

ANNEXE BB / APPENDIX BB

Quantitative and qualitative relationship between demersal resources of the Adriatic in connection to bottom sediments and sea depth

by

A. Simunović and S. Jukić
Institut za oceanografiju i ribarstvo, Split, Yugoslavia

1. INTRODUCTION

The first extended investigation of quantitative and qualitative aspects of Adriatic demersal resources by means of bottom trawl net was undertaken during the trawl-survey expedition "HVAR" in 1948/49 (O. Karlovac, 1959). Though the main purpose of this expedition was the evaluation of quantitative and qualitative aspects of edible trawl catch resources (fish, cephalopods, crustaceans) it should be noted that relationship between edible and non-edible trawl catch was also preliminarily studied.

More recent investigations, especially of quantitative and qualitative aspects of demersal resources along the eastern Adriatic coast (Zupanović, 1961; H.B. Gamulin, 1962), have shown more precisely relationships between groups of demersal resources and their changes in connection to bottom sediments composition and sea water characteristics.

Wider investigations of relationships between benthic communities were carried out by Jukić and Simunović (1982) - in press - when quantitative and qualitative aspects of demersal resources concerning sea depth were treated.

Excluding the thesis of the existence of various categories of the benthic communities (Petersen, 1913; Jones, 1950; Thorson, 1951, 1957; Longhurst, 1958), on the occasion of three "Pipeta" expeditions undertaken in 1982 over 54 fixed stations and 9 profiles we tried to get preliminarily information on relationship between benthic communities within trawl fishing grounds with the main types of bottom sediments in the Adriatic and sea depth.

The main purpose of these investigations has been more detailed description of biocoenological relationship among benthic resources, to assess production characteristics and potentials and finally to draw "trawl fishing grounds charts" of general interests for management purposes.

2. RESULTS AND DISCUSSION

Division of biomass of edible and non-edible trawl catch collected during "Pipeta" expeditions has been done according to the main types and distribution of bottom sediments over the Adriatic continental shelf, i.e. by means of the map prepared by CNR-Istituto di Geologia Marina, Bologna. (Page 49 of the report of the Second Technical Consultation on Stock Assessment in the Adriatic. With regard to this map and areas covered by "Pipeta" expedition stations, investigated areas might be divided into five dominant regions: "relict" sand, clayey silt-silty clay, silty sand-sandy silt and loamy fishing grounds.

Two approaches were used: first, pre-planned stations in the laboratory were fixed according to the main trawling grounds so that geographic position of the stations in connection to the type of bottom sediments were considered; secondly, concerning collected material during the expedition, especially on the basis of dominant demersal groups and species of non-edible trawl catch, it was tried to reconstruct and describe the characteristics of the trawl fishing grounds in connection to bottom sediments and sea depth.

With regard to collected material during spring-summer (April/May) and autumn-winter (November/December) cruising periods it has been possible to recognize significant quantitative and qualitative changes among benthic resources owing to the sediments components and sea depth.

According to the data presented in Table 1 (a, b, c, d, e) it can be observed that indices of relative index of abundance (catch per unit effort) of fish populations, in relation to the type of bottom sediments, is the highest on "relict" sand stations and clayey "relict" sand (table 1a and b) with abundance average values from 25.02 to 39.53 kg/hour.

On the contrary, the smallest index of fish abundance was found over the stations with silty sand and sandy silt (table 1d) from 10.23 kg/hour to 8.03 kg/hour on clayey silt and silty-clay bottoms.

As far as group Cephalopoda is concerned highest values on index of abundance were found over stations with "relict" sand sediments (table 1a) from 10.29 to 17.37 kg/hour and smallest ones on clayey silty and silty clay sediments 1.16 kg/hour on depth above 100 metres.

The distribution of crustacea decapoda, especially the species Squilla mantis (L) is registered on silty sand and sandy silt bottom sediments with average values 3.07 kg/hour to 0.57 kg/hour as well as on loam sediments 0.02-0.57 kg/hour. Other species: Nephrops norvegicus (L) has been mainly distributed on clayey silt and silty clay sediments with abundance from 0.10 to 2.11 kg/hour and in loam area 0.65 to 1.90 kg/hour. The index of relative abundance of these two species fluctuates according to seasonal species behaviour (Jukić, 1971).

The highest values of non-edible trawl catch biomass has been found out for the stations with "relict" sand, ranging from 353 to 687 kg/hour (table 1a) in sea depth to 100 metres and it is worth noting that this biomass is mostly made of single species: Chlamys opercularis (L). Smallest biomass of non-edible trawl catch is registered on stations with clayey silt and silty clay sediments (table 1c) from 1.50 to 8.00 kg/hour. On the stations with loamy sediments, up to 50 metres, quantity of non-edible abundance has been fairly high, 219 kg/hour, and in this biomass the species Portunus depurator (L) made up 60 to 90 per cent of the catch.

Similar regularities within benthic communities were observed during the "HVAR" expedition in 1948/49, but because of differences in the coefficient of catchability of the bottom trawls used by "Hvar" and "Pipeta" it has been almost impossible to compare some findings, especially those in connection to sediments composition and distribution in great part of shallower and northern Adriatic. Very close to these findings are the results of Jukić and Simunović (1982, in press) who stated relationship between ichthyofauna and epifauna in the Northern Central and Southern Adriatic.

3. CONCLUSION

With regard to studies of quantitative and qualitative relationship between benthic resources i.e. edible and non-edible trawl catch, it was possible to observe a close connection of communities to the structure of the bottom sediments and the sea depth. It is hoped that on the basis of these relationships it will be possible in the future to precise bio-ecological connections among demersal resources, especially those of trawling grounds for management purposes.

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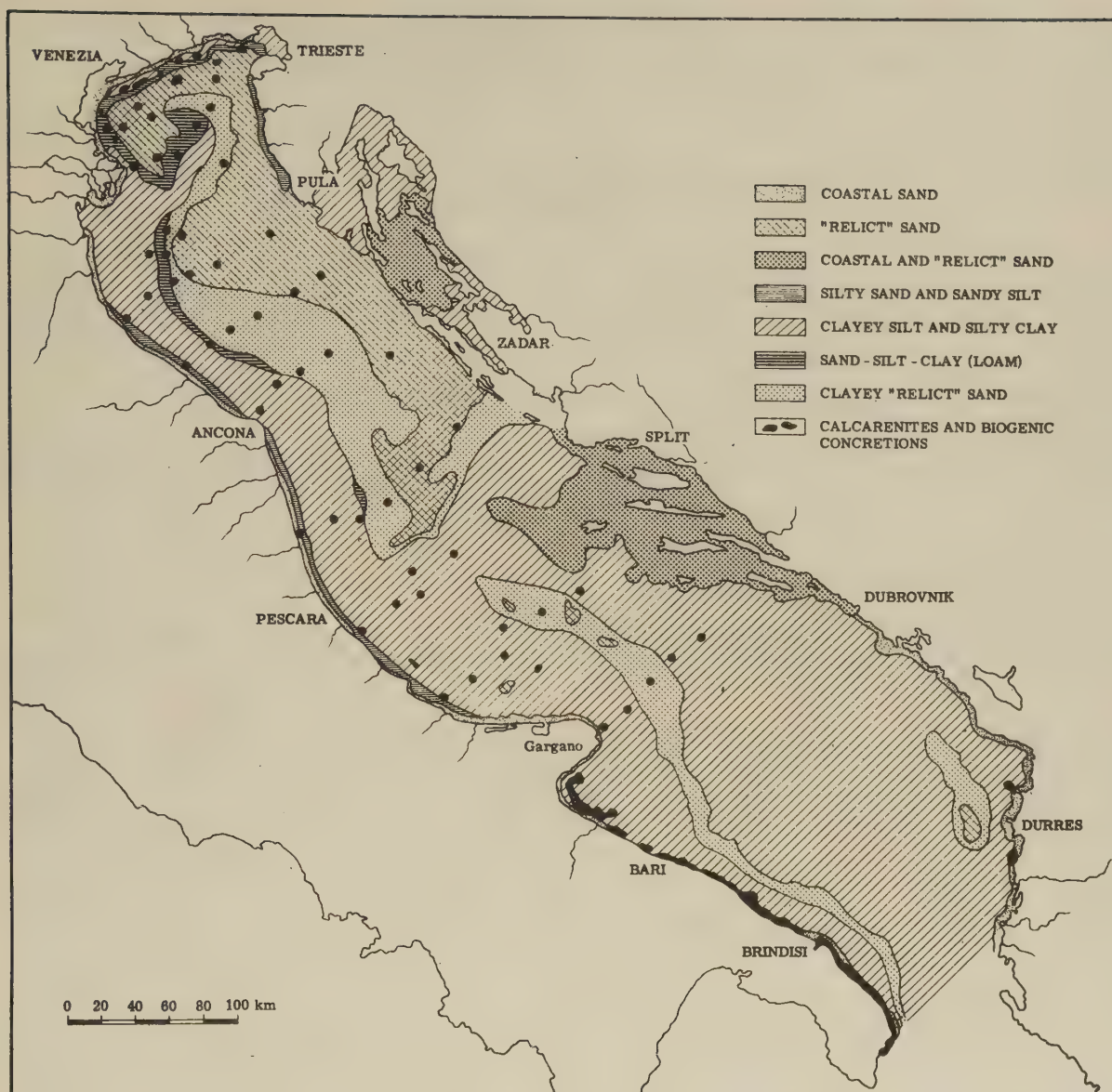


Figure 1: Distribution of sediments and "Pipeta" stations position in the Adriatic sea.

(Map taken from ANNEX (E) E "Distribution des sédiments/Sediment distribution" of the Report of the Second Technical Consultation on Stock Assessment in the Adriatic. FAO Rapp. Pêches, (253), p.49.

TABLE 1 : Average values of edible and non-edible trawl catch abundance (kg/hour) in connection to sea depth and bottom sediments.

a/"RELICT'SAND

DEPTH (m)	P I S C E S		CEPHALOPODA		NEPHROPS NORVEGICUS		SQUILLA MANTIS		: NON-EDIBLE	
	kg	%	kg	%	kg	%	kg	%	kg	%
to 50 (n=7)	27,66	47,67	17,47	62,93	/	/	/	/	685,00	65,99
51-100(n=4)	30,48	52,42	10,29	37,07	/	/	/	/	353,00	34,00
total	58,14		27,76						1038,00	

b/ Clayey "relict" sand

to 50 (n=3)	39,13	29,07	5,41	40,40	/	/	/	/	188,50	48,18
51-100(n=3)	25,02	18,59	1,62	12,09	/	/	/	/	94,50	24,15
101-150(n=1)	38,37	28,51	3,95	29,49	/	/	/	/	83,00	21,22
above150(n=1)	32,04	23,81	2,41	18,00	/	/	/	/	25,20	6,44
total	134,56		13,39						391,20	

c/ Clayey silt and silty clay

to 100(n=2)	10,60	15,67	2,24	17,98	0,40	7,09	/	/	8,00	40,40
101-150(n=6)	8,80	13,01	1,16	9,30	2,11	37,41	/	/	3,10	15,66
151-200(n=2)	8,03	11,87	2,30	18,46	1,53	27,13	/	/	3,70	18,69
201-250(n=2)	19,37	28,63	2,48	19,90	1,50	26,60	/	/	3,50	17,68
above250(n=1)	20,84	30,81	4,28	34,35	0,10	1,77	/	/	1,50	7,57
total	67,64		12,46		5,64				19,80	

d/ Silty sand and sandy silt

to 50(n=7)	10,23	/	5,99	/			3,07	/	47,00	
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e/ Loam

to 50(n=7)	17,64	65,92	5,88	82,70	1,90	74,51	0,57	96,61	219,00	92,40
above50(n=2)	9,12	34,08	1,23	17,30	0,65	25,49	0,02	3,39	18,00	7,59
total	26,76		7,11		2,55		0,59		237,00	

ANNEXE CC / APPENDIX CC

Application of production model to the Eastern Adriatic sardine
(*Sardina pilchardus* Walb.) population

by

Veronica Alegría
Institut za oceanografiju i ribarstvo, Split, Yugoslavia

1. INTRODUCTION

Since sardine (*Sardina pilchardus* Walb.) average about 55 per cent of the total Yugoslav catch and 70 per cent of the pelagic catch, the effects of fishing on standing sardine stock in the Adriatic is of great importance.

Long-term catch and fishing effort statistics for the eastern Adriatic coast provide a basis for the analysis of the population state applying linear (Schaefer, 1954) and exponential (Fox, 1970) production model. On this basis the stock size of sardine along the eastern Adriatic coast, where purse-seining has been developed since a long time, may be estimated as well as the relationship between the population size, intensity of fishing and catch.

2. MATERIAL AND METHOD

The applied method is based on Yugoslav annual catch statistics for the 1967 - 1982 period.

In calculating the catch per unit effort, fishery statistics of one fishing organization was used. The purse-seiners fleet of this organization operates along the eastern Adriatic coast, fishing mostly for sardine. These fishing vessels count among the biggest government fishing boats (98-109 gross tonnage, 240 - 400 HP).

Fishing effort unit used is one fishing boat/day with only one net shot. Fishing effort was calculated as a three year mean since it is held that, in the course of a defined year, the population is not only affected by the fishing effort exerted during that particular year but also by the fishing effort applied in the two preceding years owing to the fact that sardine are fully recruited after the second year of age.

3. RESULTS

Annual sardine catch trend in the analysed period 1967-1982 shows continuous increase with the index of 1,218.794 tons per year ($r = 0.896$).

Statistics collected also prove that sardine catch along the eastern Adriatic coast is of seasonal character, as well as the catch of other small pelagic fish. Larger catches are mainly made in autumn coinciding with the highest abundance indices. Summer catches coincide with the highest effective fishing effort and low abundance index (Alegría Hernández, 1981).

Calculated correlation between the applied fishing effort and the catch per unit effort proved to be very significant ($P < 0.01$) according to both Schaefer and Fox models. The functional dependence of these two parameters allows the application of production model to sardine fishing along the eastern Adriatic coast.

Biological characteristics of exploited sardine population meet the requirements for better and more accurate application of surplus model results (Fox, 1977):

- life cycle of exploited population individuals is 8 - 9 years which is the upper limit of the recommended range;
- II, III and IV age groups are predominant;
- sardine enters the exploitation stage at the end of the second year of age;
- available data series cover 16 years which is a sufficiently long period.

From the analysis of functional values it is evident that the annual fishing effort trend slowly and continuously declines ($b = -177.123$ fishing days/year, $r = -0.763$). In addition, applied fishing effort shows narrow variation range.

It was established that the number of fishing days per year that should be realized was lower than the average fishing days realized so far ($\bar{f} = 6,864$ effective fishing days). Effective fishing effort values from recent years, however, vary about estimated optimum fishing effort.

Mean annual catch per unit effort gradually increases from one year to another accompanied with a little reduction of fishing effort, what indicates that the population continuously increases.

Parameters of sardine population along the eastern Adriatic coast estimated from the linear and exponential model are given in Table 1.

Population equilibrium estimates from the relationship between catch per unit effort and respective fishing effort is given in Figure 1. Scattering of points ($\bar{U}, f$) shows that statistical data are well fitted to surplus yield model. However, linear model somewhat better describes the population state.

Figure 2 depicts the relation between equilibrium yield and fishing effort.

Assuming that Schaefer curve is better, the maximum sustainable yield is 25,428 tons per year with optimum fishing effort of 4,806 effective fishing days. However, this estimate may be inadequate since it may not be said with certainty that sardine population attained the highest stock size level. By an earlier fitting of linear and exponential models to the 1967-1978 period it was estimated that MSY should be about 21,000 tons per year and optimum fishing effort should range from 4,100 to 5,300 fishing days, after the exponential and linear model respectively, with the low fishing mortality coefficient ($F_{MSY} = 0.2$) (Alegria Hernández, 1981). No significant differences were observed four years later.

Table 1: Parameters of the eastern Adriatic sardine population estimated by the linear and exponential production models for the 1967-1982 period.

Parameters	Linear	Exponential
Correlation coefficient	- 0.784	- 0.777
Rate of fishing at MSY	0.225	0.169
Maximum sustainable yield (tons)	25,427.781	24,340.300
Optimum fishing effort (fishing day)	4,806.399	3,609.322
Optimum catch per unit effort (kg)	5,290.403	6,743.732
Stock size at MSY (tons)	113,012.360	144,025.440
Optimum stock size (tons)	113,042.790	144,096.840
Maximum population size (tons)	236,085.580	391,695.830

Catchability coefficient was calculated by the method of Gulland (1964), that is the regression between total mortality coefficient, calculated from monthly catch, and respective fishing effort. However, the analysis of the relation between these variables shows poor correlation significance ($0.05 < P < 0.1$). This may be accounted for by the variable catchability coefficient values. Obtained catchability coefficient $q = 4.68 \times 10^{-5}$.

On the basis of that linear relation the following values were also estimated:

- average fishing mortality coefficient $\bar{F} = 0.308$.
- total mortality mean coefficient $\bar{Z} = 1.049$
- natural mortality coefficient $M = 0.741$

Accordingly, the exploitation rate ($E = 0.304$) of sardine population along the eastern Adriatic coast is constantly low.

Catchability coefficient was found to be reduced and inversely related to stock size up to 1979. It may be assumed that only a part of population inhabiting this area was under constant exploitation.

Year-to-year variations of sardine catchability coefficient in relation to abundance index variations show that catchability coefficient trend most probably is not due only to natural changes in stock size but also to the changes of population aggregation and dispersion in space. Range of population geographical distribution is not reduced but changes in space and seasonally,

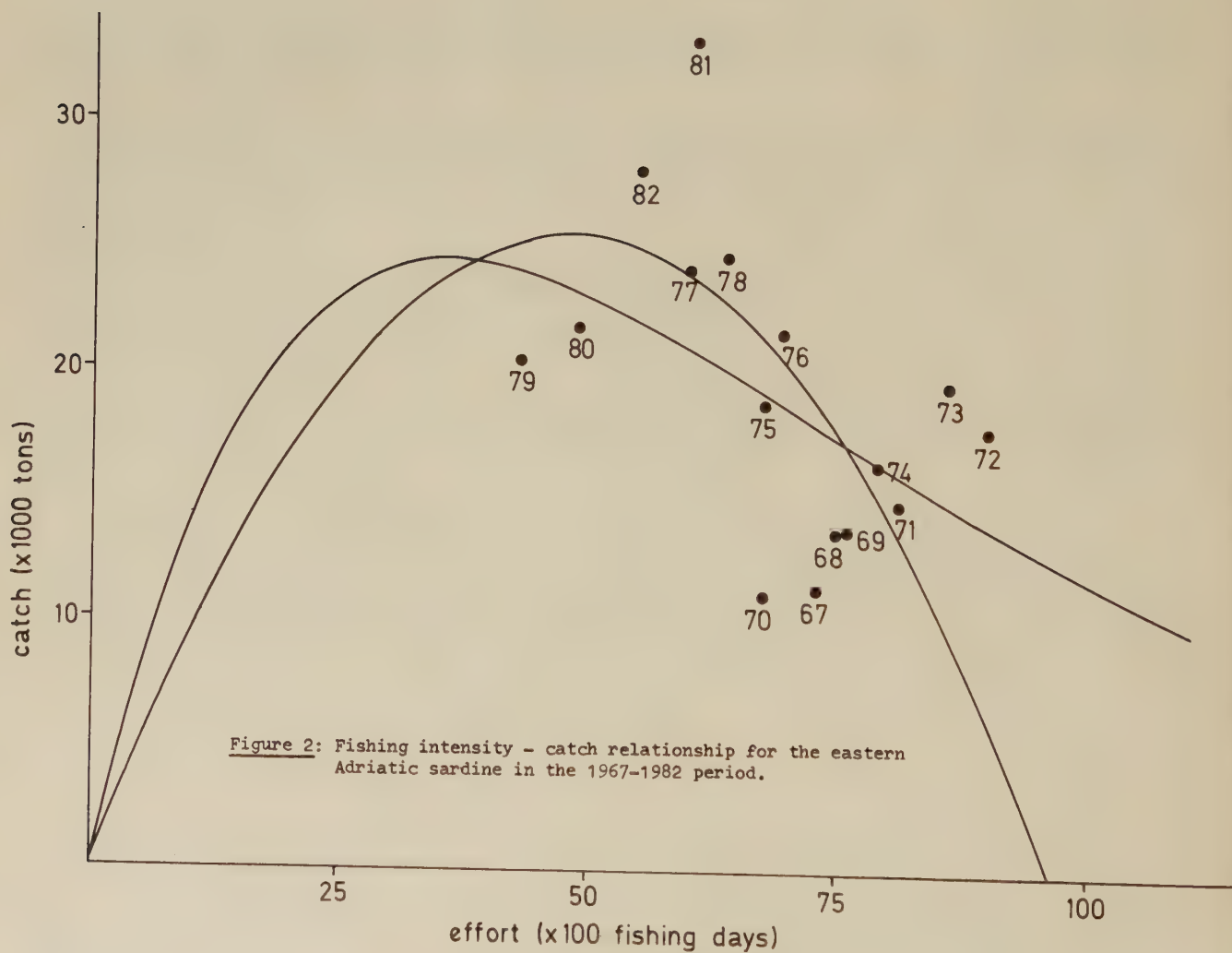
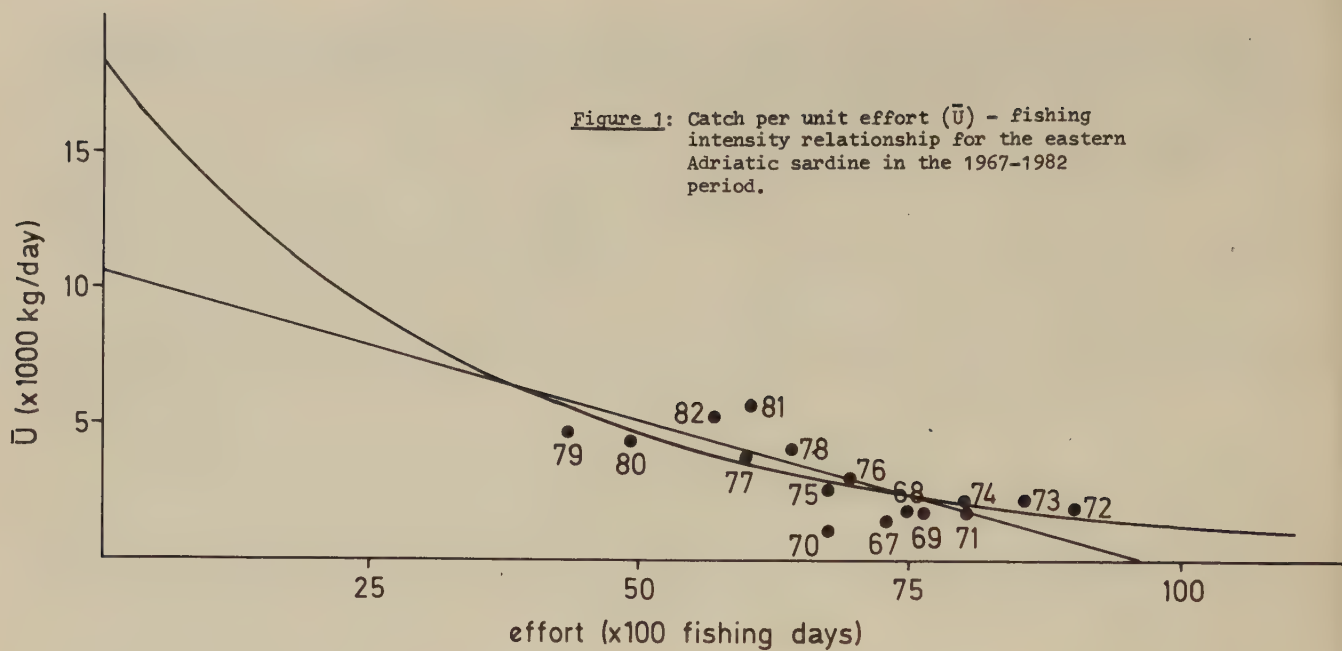
in dependence of population biological requirements, due to what population vulnerability is also changed. This was found by Algría Hernández and Jukić (1981), who analysed seasonal variations of catchability coefficient of the eastern Adriatic sardine. Namely, maximum values were recorded in autumn and spring and minimum values in summer.

4. CONCLUSIONS

1. On the basis of production model it was estimated that the optimum sardine stock size varied between 113 and 144.000 tons after linear and exponential models respectively.
2. Sardine stock size of 54.000 tons in 1967 amounted to 126.000 tons in 1979 to be reduced to 90.000 tons in 1982.
3. Estimated stock size allows maximum sustainable yield of 25.000 tons per year and optimum fishing effort of 4,800-3,600 effective fishing days per year after the linear and exponential models respectively.
4. The recently reported sardine catch and fishing effort vary around the optimum values given by the production model for this Adriatic area.
5. Fishing effort variations range is rather small thus it could account for the annual catch increase only to a certain extent. In this case the predictive possibilities of the model are limited.

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ANNEXE DD / APPENDIX DD

Preliminary results on the assessment of two stocks of small pelagic fish of the Northern-Central Adriatic Sea: *Sardina pilchardus*, Walb. and *Engraulis encrasicolus*, L.

by

D. Levi */ , N. Cingolani, G. Giannetti, R. Scorcelletti, E. Peloni and N. Frontini **/

*/ Istituto di Tecnologia della Pesca e del Pescato-Mazara del Vallo.

**/ Istituto di Ricerche sulla Pesca Marittima - Ancona.

SUMMARY 1/

This draft was too long to be published as an appendix to the report and needed some scientific editing. A final version is being prepared and the reader may write to the authors for more information.

The paper presents the first set of extensive results of the analysis of a data base progressively built since 1974. The data base organization is described as well as the difficulties met in his building up over years. This document elaborates essentially on sardines although data on anchovies are available as well and will be processed soon.

The method developed to standardize units of fishing effort ("days spents fishing for small pelagics") overcoming the major difficulties which prevent the application of usual standardization techniques to this particular fishery has been then illustrated in some detail. A simple global production model has been then fitted to six years of catch and effort data of both sardines and anchovies.

Some management measures seem to be necessary for sardines only, as MSY (20.000 tons) was approximately reached in 1976, with an effort of 9.500 days.

Data on the sardine population structure were utilized to check the conclusions reached by the simple model and to try to explain their real causes, as there is evidence of a "relatively limited increase of fishing effort" during the time interval taken into consideration.

Two vectors of total mortality yearly rates were produced applying two different catch curves to the same matrix of catch in numbers at ages every year (which in turn had been calculated crossing yearly age-length keys by port with yearly length-frequency distributions of catches by port):

- a) through year-columns: catch curve analysis (Programme frg 705-Abramson, 1970), (Chapman and Robson, 1960; Robson and Chapman, 1961);
- b) through diagonals of values of the same matrix divided by the correspondent standardized effort (Gulland, 1955; Ricker, 1975: pag. 39, 40): successive abundance indexes of true cohorts.

A

B

Years	75	76	77	78	79	80	75	76	77	78	79	-
Z =	0.71	0.58	0.51	0.56	0.52	0.53	0.85	0.77	0.69	0.66	0.71	-

A vector of yearly values of natural mortality coefficients was obtained by Pauly's (1979) equation utilizing V.B.G.E. parameters (calculated by inputting yearly average lengths at age in all ports "pooled" together into programmes BGC3 by Patrick Tomlinson, 1975) and a rough estimate of the average surface temperature of the waters where the fish spend the early time of their life (instead of "the mean annual temperature at the position where the fish were caught"):

1/ The original draft submitted at the Consultation consisted of 24 pages of text, 16 sheets of tables and graphs, 6 pages of references, plus three appendices:

1. "Data base organization" by N. Cingolani and R. Scorcelletti,
2. "Age-reading of anchovy otoliths. A first methodological note" by G.F. Giannetti,
3. 16 sheets of summary tables (printouts) with relevant statistical data utilized for the paper.

years	75	76	77	78	79	80
Z =	0.50	0.52	0.43	0.43	0.45	0.32

As some problems still exist for age determination of sardines by scale readings, and some doubt on the aforementioned age-length keys, thereafter, we felt the need to validate the generalized Von Bertalanffy growth equation parameters running a fortran version of Pauly's elefan 1 Programme on length frequency distributions of at least year 1976, chosen as the reachest for length measurements; results were rather encouraging.

For the same year 1976, a fortran version of elefan 2 gave $M = 0.839$ and $F = 0.161$ ($Z = 1.0$), which could be compared with $M = 0.50$ and $F = 0.21$ ($Z = 0.71$) previously obtained from age data analysis instead of length data analysis, for the same year.

The two different vectors of M previously reported, allowed us to run two different cohort analysis with M varying every year. They were used: (1) to get estimates of sardine population numbers and biomass every year (and at different ages); (2) to calculate annual average fishing mortality (as geometric mean of F at ages). The results were given in tables 1 and 2 .

Plotting these annual fishing mortalities against yearly measures of standardized effort, a very good regression line, almost passing through the origin, was obtained.

Population numbers and biomass at ages obtained by cohort analysis, were also utilized for a first attempt to study the stock-recruitment relationship (age group 0 = Recruitment, and age groups 1 to 7 = spawning stock size) and $S = 1 - 7$ groups values of S_m , R_m and S_r calculated by the programme Ricker 1 (Abramson, 1975) with both sets of data coming from the two cohort analysis, could support the main results of the application of the production model and could provide for a possible explanation for the relatively bad state of the resource notwithstanding the weak increase of fishing effort during the considered period.

Table 1. Catch in numbers (C), population numbers (N), individual weights at age ($\bar{w}$), biomass (W) and Recruitment (ΣN) (Numbers in millions, weights in tons, individual weights in grammes), values in brackets are estimates)

	1975/1976		1976/1977		1977/1978		1978/1979		1979/1980	
C ₀	76	187			186		981		945	
N ₀	2073	1905			1042		(956)		(531)	
$\bar{w}_0$ W ₀	25.67	25.82	49181		25.53	26618	24.56	23489	25.63	13624
C ₁	89	125			161		154		146	
N ₁	241	1186			1046		528		(531)	
$\bar{w}_1$ W ₁	34.39	33.25	39440		31.21	32644	31.67	16717	32.48	11262
C ₂	85	104			128		107		99	
N ₂	1100	1381			635		550		216	
$\bar{w}_2$ W ₂	38.69	38.10	52621		37.40	23769	36.55	20123	38.65	8364
C ₃	47	92			137		79		94	
N ₃	375	594			772		310		269	
$\bar{w}_3$ W ₃	42.62	41.46	24660		41.71	32225	41.97	12999	42.36	11396
C ₄	15	51			104		50		41	
N ₄	482	189			295		392		136	
$\bar{w}_4$ W ₄	47.26	44.02	8319		45.04	13302	44.79	17661	47.49	6415
C ₅	12	23			32		25		33	
N ₅	337	176			77		108		91	
$\bar{w}_5$ W ₅	52.38	48.61	858		47.21	3629	48.80	6295	50.34	10677
C ₆	0.3	0.8			2.0		7.7		13.7	
N ₆	0.9	1.1			3.6		24		49	
$\bar{w}_6$ W ₆	55.03	52.78	57		60.89	1847	60.81	1220	51.68	2553
C ₇	0.07	0.19			0.03		0.63		3.7	
N ₇	(0.2)	0.33			0.06		0.74		9.2	
$\bar{w}_7$ W ₇	56.04	52.22	17		56.38	3	52.07	39	49.21	454
W ₁₋₇			125972			105757		73933		57200
N ₀₋₇ W ₀₋₇	6016	5275	175153		3332	132375	2869	123237	1956	70824
R = $\Sigma_1^7 N$	3943	3370			2290		1913		1424	

Table 2: Natural, fishing and total mortality rates.

	75-76	76-77	77-78	78-79
$\hat{M}$	0.51	0.48	0.43	0.44
Z0-1	0.56	0.60	0.68	-
F0-1	0.05	0.12	0.25	(0.45)
Z1-2	0.56	0.62	0.64	0.89
F1-2	0.05	0.14	0.21	0.45
Z2-3	0.62	0.58	0.72	0.72
F2-3	0.11	0.10	0.29	0.28
Z3-4	0.69	0.70	0.68	0.82
F3-4	0.18	0.22	0.25	0.38
Z4-5	1.01	0.90	1.01	0.61
F4-5	0.50	0.42	0.58	0.17
Z5-6	1.14	1.58	1.16	0.78
F5-6	0.63	1.10	0.73	0.34
Z6-7	1.00	2.94	1.59	0.96
F6-7	0.49	2.46	1.16	0.52
$\bar{F}$	0.186	0.329	0.408	0.336

ANNEXE EE / APPENDIX EE

Biomasse instantanée zooplanctonique et ressource pélagique

par

Mario Specchi

Institut de Zoologie, Université de Trieste, Italie

Serena Fonda-Umani

Institut de Zoologie, Université de Trieste, Italie

Corrado Piccinetti

Laboratoire de Biologie marine et de Pêche, Fano, Italie

Les rapports entre la biomasse instantanée (standing-crop) phyto-et zooplanctonique et la quantité de poisson pélagique (oeufs et larves ou adultes) dans l'Adriatique ont déjà fait l'objet de recherches en Yougoslavie (Vučetić, 1971; 1975; Vučetić et Kačić, 1973; Svirn, 1969). En particulier Vučetić (1975) note que la ponte de l'anchois (Engraulis encrasicolus) et de la sardine (Sardina pilchardus) se produit toujours après le maximum de la biomasse du zooplancton, à l'exception de la baie de Kastela (Split) dans laquelle les deux phénomènes sont contemporains. L'auteur met en évidence l'importance du zooplancton comme nourriture pour le stock des petits poissons pélagiques.

Štirn (1969) note l'importance de la chaîne trophique Nitzschia-Penilia-Engraulis dans la zone de déversement du fleuve Pô.

On a aussi vérifié cette importance dans le golfe de Trieste dans lequel, en accord avec les conclusions de Vučetić, on a observé une bonne corrélation entre les maximums de la biomasse zooplanctonique (exprimée comme poids sec) et les maximums de ponte de l'anchois qui ont lieu à la fin du printemps. La ponte de la sardine, au contraire, a lieu en hiver dans les eaux au large de toute l'Adriatique exception faite pour la zone de l'île de Jabuka et pour la fosse de l'Adriatique du sud; toutefois dans le golfe de Trieste en particulier, mais en général dans toutes les zones côtières de l'Adriatique dans lesquelles le trophisme est important, la sardine en été est dans sa phase trophique qui précède la gamétogénèse et la ponte.

Au cours des recherches périodiques effectuées par Piccinetti, Regner et Specchi pour la détermination quantitative du stock d'anchois et de sardine dans l'Adriatique par la méthode des oeufs et larves on a recueilli du matériel planctonique qui est actuellement en phase d'étude et d'élaboration.

Un premier résultat est toutefois présenté dans ce document et se réfère aux corrélations entre la biomasse instantanée zooplanctonique et la quantité d'oeufs d'anchois récoltés dans le plancton et donc, à cause du développement rapide des oeufs de cette espèce, entre la biomasse instantanée et les reproducteurs.

Comme l'avaient déjà démontré Benović et al. (sous presse), le poids sec et, mieux, le poids de la substance organique sont un très bon indicateur de la production au second niveau de la chaîne trophique. Pour cela la corrélation entre ces deux facteurs et le nombre d'oeufs présents peut être prise comme index effectif de la corrélation entre le deuxième (zooplancton) et le troisième (poissons pélagiques) niveaux de l'échelle trophique.

Les résultats en objet se reportent à une croisière effectuée dans les premiers jours de septembre 1979 sur 58 stations dans toute l'Adriatique au nord de la transversale Gargano-Kotor.

Les corrélations entre poids sec et poids de la substance organique d'un côté et la quantité d'oeufs de l'autre ont un degré significatif très élevé:

Poids sec/oeufs	$r = 0,71$
Poids de la substance organique/oeufs	$r = 0,68$

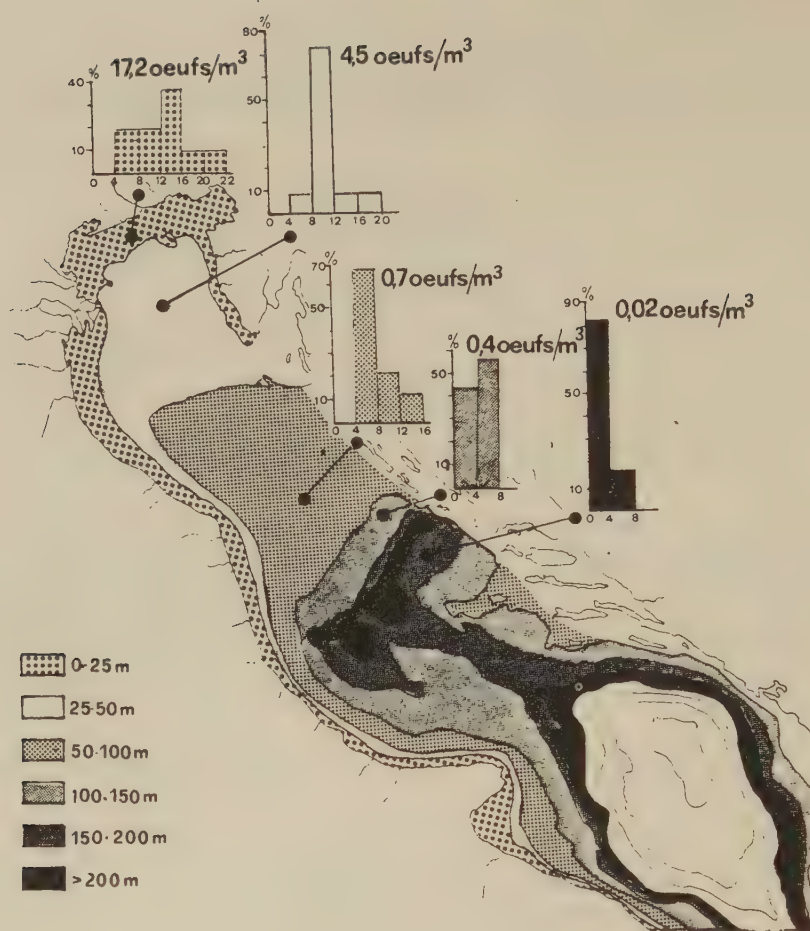


Figure 1: Fréquence en pourcentage du poids de la substance organique (en mg/m³) des zones considérées et nombre d'oeufs d'anchois.

Pour ce qui se réfère à la distribution des valeurs de biomasse on a vu qu'il existe un gradient de distribution qui va de la côte vers le large et que les lignes bathymétriques de 25, 50, 100, 150 et 200 m délimitent des zones à trophisme décroissant (Figure 1). A ce trophisme correspond, à cause du haut degré de signification de la corrélation citée, une distribution décroissante des oeufs de l'anchois et donc des reproducteurs (Figure 1).

Dans ces données préliminaires qui se réfèrent pour la première fois à toute l'Adriatique, même si elles sont limitées à une seule croisière, on confirme le degré élevé de trophisme de la zone néritique de l'Adriatique qui peut soutenir une haute productivité en petits poissons pélagiques.

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ANNEXE FF / APPENDIX FF

Some applications and preliminary results of acoustic methods in
monitoring pelagic resources in the North and Middle Adriatic Sea

by

M. Azzali, G. Cosimi and M. Luna
C.N.R. - I.R.P.E.M. Molo Mandracchio - 60100, Ancona, Italy

ABSTRACT

The paper describes some applications and preliminary results by managing, with a data base system, the acoustic data derived from six echosurvey cruises in the North and Middle Adriatic Sea.

Two applications are illustrated: relative and absolute estimates of pelagic biomass as a whole and preliminary estimates of sardine and anchovy stocks. The comparison of fisheries data and sardine estimates seems to give, as a result, a relatively close dependence between the two graphs.

1. INTRODUCTION

Since June, 1976, 6 echo-integrator survey cruises, associated in the period 1980-82 with biological stations, have been carried out as a part of a C.N.R. scientific programme for assessing biological resources in Italian/international waters.

The "end products" of these cruises have been, recently, stored in a data base subdivided in seven sets of data:

- (i) Geographical data (land contours, depth contours, etc.);
- (ii) Cruise data (species under examination, latitude corner, Longitude corner, Date begin, Date end);
- (iii) Raw acoustic data (echograms, integrations, recorder echosignals, etc.);
- (iv) Fish targets (aggregation depth, thickness, horizontal dimensions, estimated packing density, etc.);
- (v) Biological station data (sample taken from acoustic targets with nets for target identification and for use as biological material).
- (vi) Species composition (species name, its percentage by weight and number in the catch, etc.);
- (vii) Length frequency distribution (size class and frequency).

The data base enables a large number of users to ask a wide variety of questions through the use of appropriate programmes that can be incorporated in the data base management-system. The main use of the programmes is to give information on:

- (a) relative and absolute estimates of the biomass and variability with time:
 - of the pelagic population as a whole,
 - of any sub-population (Anchovy, Sardine, Sprats, other pelagic species),
 - of length classes
- (b) geographical distribution and its variability with time:
 - of the pelagic population as a whole,
 - of any sub-population,
 - of length classes.
- (c) Comparison with fisheries data, statistics, etc.
- (d) Research on aggregation structure and behaviour
- (e) Acoustic research (used survey strategy, precision and accuracy of surveys, equipment development, etc.).

At present the programmes that could permit the access to all the acoustic data are in development. Therefore only some applications and preliminary results, derived from managing acoustic data through the use of a data base system, will be illustrated.

2. RETRIEVAL OF ACOUSTIC DATA FOR ASSESSING BIOMASS AND DISTRIBUTION OF A PELAGIC POPULATION (AS A WHOLE)

This programme is designed to retrieve information (year by year) on:

- (a) the used survey strategy
- (b) pelagic population distribution
- (c) relative and absolute estimates of pelagic biomass.

The process falls into five main stages:

- (i) The map of the surveyed area is plotted in this order:
 - land contours,
 - depth contours (if required)
 - political borders (middle line territorial waters, etc. if required)
- (ii) The used survey strategy or the relative biomass distribution or the absolute biomass distribution is superimposed.
- (iii) A summary of instruments and their knob settings, during the survey, is printed.
- (iv) A table of the relative estimates of the pelagic biomass, per stratum, is printed.
- (v) Finally, assumed an average length of 15 cm for the pelagic population; the calibration constant is calculated and a rough (preliminary) biomass estimate, per stratum, is produced.

During the development of this programme, changes can be made by users, without affecting the performance of the process.

For example a different length of pelagic population may be introduced or the assessment calculated using only the daytime (or the night time) acoustic data.

Other possibilities offered by the programme are:

- to assess the pelagic population per areas. In this case a new chart or "window" is produced for the required area (covered by the data base).
- To estimate the statistical error due to the operation of two dimensional interpolation.
- To scale the survey data up to the total area occupied by the stock.

The sets of data involved in the above programme are the ones labelled with (i), (ii), (iii) in chapter 1.

2.1 Preliminary results on pelagic biomass inside the surveyed area

Figure 1 illustrates the strategy of the first successful echo-survey, that was carried out in June 1976, in connection with FAO.

The distribution of pelagic biomass is plotted in figure 2 (3 stratum). The automatically reprocessed data gave a pelagic biomass estimate in the surveyed area (8456 square n mile) of 192.000 tons, that is not too far from the value calculated manually (110.000 tons) on a smaller area (3858 square n mile) in 1976.

The second survey (Figure 3), carried out approximately 13 months later, well controlled technically, gave an estimate that was thought too high (450.000 tons).

The automatically reprocessed data has given a pelagic biomass of 288,425 tons, that is a less drastic increment as to 1976.

The distribution of pelagic biomass in the surveyed area (9934 square n mile) is plotted in Figure 4.

The average biomass density, in the surveyed area, has been estimated as 29 tons/square n mile.

The next survey (Figure 5), made approximately 7 months later (February, 1978), showed a sharp increase of the pelagic biomass. However the environmental and biological conditions, together with the design and execution of the survey carried out in winter season, are only hardly comparable with the ones of 1976 and 1977.

The automatically reprocessed data has confirmed a strong increment of observed biomass: pelagic biomass: 360,000 tons; average density 93.5 tons/square n mile. The map of pelagic biomass distribution (Figure 6) in the surveyed area (3,845 square n mile) shows evident differences with the two former maps. However the variability (or the persistence) of the geographical distribution of a pelagic population is a topic in itself, and not even few comments are appropriate here.

For technical reasons, the next survey could be carried out only 17 months later (July, 1980; Figure 7). It yielded an estimate of pelagic biomass of 350,000 tons and an average density in the surveyed area (7,100 square n mile) of 49 tons/(square n mile). The pelagic biomass distribution in the surveyed area is plotted in Figure 8.

The last two surveys, made respectively in September 1981 and in September 1982 (Figures 9 and 10), were surrounded by uncertainties related to the research vessel, in which a new propeller had been installed. Therefore at present only the distribution of the pelagic biomass can be provided (Figures 11 and 12). However it seems possible to extract fish signals from the propeller noise, also if it is a time-consuming procedure. Preliminary results of this procedure seem to indicate an evident increase of the pelagic biomass.

Note:

The most important sources of bias errors in acoustic estimates are:

- (a) Calibration procedure and sampling statistical errors.
- (b) Coverage errors
- (c) Vessel avoidance (fright reaction).

Of these, only the factor (a) can be calculated (+ 30 per cent rounded) and might produce a positive or negative error in the estimate. The factors (b) and (c) produce an under estimate of the total pelagic biomass, but the errors arising from the lack of coverage and fright reaction of fish can not be estimated.

2.2 Scaling the survey results up to the total area occupied by the pelagic stock

The acoustically surveyed area covers only a portion (25 per cent rounded) of the total area occupied by the standing pelagic stock.

The probable geographical area of the standing pelagic stock extends from the Gulf of Venice and Trieste down to the line connecting Monte Gargano and Cape Ostra at the entrance of Boka Kotorska (29511 square n miles (Piocinetti *et al.*, 1980), that marks a clear border at least from a morphological and hydrological point of view.

If the acoustically surveyed area (7500 square n. mile, average 1975/80) can be considered a consistent test for the whole distribution area of the standing pelagic stock, then the pelagic biomass of the standing pelagic stock, averaged in the period 1976/1980, can be estimated as follows:

- minimum value: 0.7 million tons
- average value: 1.5 million tons
- maximum value: 2.8 million tons

An open problem is:

what is the error in scaling the survey results up to the total area occupied by the stock?

3. RETRIEVAL DATA FOR ASSESSING BIOMASS AND DISTRIBUTION OF ANCHOVY AND SARDINE STOCKS

This programme is designed to retrieve information on:

- (a) anchovy stock preliminary assessment,
- (b) sardine stock preliminary assessment,
- (c) sprat and other pelagic species preliminary assessment,

(d) geographical distribution of:

- each stock
- length classes.

(e) Final assessment of each stock considering the geographical distribution and the length classes.

The process of classification, per species, of the acoustic data falls into three stages:

- (i) the raw acoustic data (echograms, integrams, echosignals, etc.), the fish targets (organism aggregations, schools, etc.) and the samples of acoustic targets taken with a net, fisheries data (if available) are processed all together, independently of their geographic position, avoidance during pelagic trawling, etc. A rough estimate of the presence of each species (in percentage) in the surveyed area is calculated. Finally, preliminary data on the biomass of each stock are provided, using the calibration constant of the pelagic stock.
- (ii) The acoustic data classified in the stage (i), the samples of acoustic targets, corrected assuming different probabilities of capture for different species (larger fish have lower probabilities of capture), are processed for a two-dimensional interpolation. The geographical distribution of each stock and of the average length classes within a stock are estimated. The countours of the distribution areas of each stock are plotted.
- (iii) The biomass of each stock is estimated using a calibration constant fitted to the species and its average length.

The last two stages of the process are allowed only if frequent samples with the net have been taken and the biological material has been carefully examined and stored. At present only the stage (i) of this programme has been completely developed and used to process the acoustic data since 1976.

If fisheries data, referring to the same areas and periods of acoustic surveys, are available, then the programme can provide a graphical representation of the acoustic estimates, for each stock, compared with the commercial catches on the same stock, for the periods of the acoustic surveys (months/years).

3.1 Preliminary results on biomass of anchovy inside the surveyed area

The anchovy biomass inside the area surveyed in 1976 was estimated at about 83.000 tons. The average biomass density has been calculated as 10 tons/square n mile.

The second estimate (July 1977) shows a slight increment of biomass (100.900 tons) and density (10.2 tons/square n mile).

The estimate of February 1978 reflects the drastic increase of biomass, reported in paragraph 2.1, and imputable mostly to the anchovy stock. The estimated biomass inside the surveyed areas was 244,000 tons, the average density 63.5 tons/square n mile.

The next survey, carried out in July 1980, indicated a drop of biomass. It gave an estimate of 191,000 tons and an average density inside the observed area of 27 tons/square n mile.

The above summarized historical review of anchovy biomass indicate that it is affected by a strong variability inside the observed area in the survey periods. The probable reason for these fluctuations must be sought out in the anchovy emigration (summer period), from, and the anchovy immigration (winter period), into, the surveyed area rather than the mortality of anchovy population.

3.2 Scaling the survey results up to the total area occupied by the anchovy stock

If the assumptions indicated in paragraph 2.2 are correct, then the biomass of the anchovy standing stock, averaged in the period 1976/1980, can be roughly estimated as:

- 0.30 million tons (minimum value),
- 0.83 million tons (average value),
- 1.90 million tons (maximum value).

3.3 Preliminary results on sardine biomass inside the surveyed area

The sardine stock has appeared in relatively large quantities inside the surveyed area only in the cruise of June 1977 (biomass 120,000 tons; average density 12 tons/square n mile).

The estimate of 1976 gave a biomass of 58,000 tons (rounded) and an average density of 7 tons/square n mile.

The estimate of 1978 indicated that the portion of sardine stock within the surveyed area was 30,000 tons (average density 7.5 tons/square n mile).

The estimate of 1980 gave: sardine biomass 48,000 tons (rounded); density 7 tons/square n mile.

In conclusion the sardine stock biomass inside the surveyed area seems to be affected by smaller fluctuations than the anchovy one; however, oddly, the fluctuations of sardine biomass affect, considerably, the commercial catch, as it is shown in paragraph 4.

3.4 Scaling the survey results up to the total area occupied by sardine stock

On the basis of the above results and under the same assumptions used for scaling the pelagic and anchovy stocks, the sardine stock in the whole area of distribution can be, roughly, estimated as:

- 0.21 million tons (minimum value),
- 0.25 million tons (average value),
- 0.36 million tons (maximum value).

The above values are averaged for the period 1976/80.

3.5 Problems in species identification

The most important sources of information for species identification, at present, are:

- (a) echosignal analysis,
- (b) samples with nets,
- (c) commercial catches in the survey period.

Of these, the echosignal analysis is affected by errors, difficult to estimate, but independent of different species under observation. Unfortunately it can be used only on a limited number of signals and needs sophisticated techniques.

The sources of information (b) and (c) are biased by errors strongly correlated to the behaviour of species. In general, due to the avoidance effect observed during pelagic trawling, sardines are expected to be under-represented in the catches and therefore under estimated (15 - 30 per cent) in comparison with anchovy, that are underestimated (10 - 20 per cent) in comparison with sprat.

This error should be compensated when the stages (ii) and (iii) of the programme indicated in paragraph 3 will be developed.

3.6 Comparisons with fisheries data

The sequential estimates of anchovy and sardine biomass in the period 1976-80 are plotted, respectively, in figures 13 and 14. The catches in the same period of acoustic survey and inside the area acoustically surveyed are also graphed to enable comparison.

The graph of the anchovy stock, inside the surveyed area, seems almost independent from the graph of anchovy catches, referred to the same area. In fact the anchovy catches increase regularly since 1975, while the estimates of anchovy biomass are affected by strong fluctuations.

The graph of sardine stock, inside the surveyed area, is not independent from the graph of catches; i.e. a high estimate (1977) coincides with large catches and, conversely, a low estimate (1978) is associated with reduced catches.

The above comparison of the graphs shows, in our opinion, the important implication of the acoustic stock estimates with respect to the fisheries management and, indirectly, demonstrates that the acoustic estimates are consistent (i.e. fishery is not influenced by the fluctuations of a large stock as the anchovy one, but is affected by the fluctuations of the sardine stock, that seems considerably smaller).

4. CONCLUSIONS

An experimental data base system regarding 6 surveys carried out since 1976 in the North and Middle Adriatic Sea has been developed at I.R.P.E.M.

At present all the acoustic data regarding the surveys have been stored; the input of biological data has not been completed.

Programmes have been written and included in the data base, but some needs further development as far as they concern species discrimination and scaling survey results up to the stock total area.

Preliminary results of data base management are summarized in table 1. It shows that the anchovy stock, averaged in the time (1976/80) and scaled to the total presumable area of the stock, has an average value more than 3 times larger than the sardine stock. Moreover it seems that a relatively close relationship between acoustic estimates and catches, taken from the portion of the sardine stock inside the surveyed area, exists. This fact, also if not well explained, entails a major responsibility for the scientific staff operating acoustic surveys.

Acknowledgements

The dynamical population department of I.R.P.E.M. is thanked for generously providing catch data for this study.

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Year	Month	AREA (n. mile) ²	S. PILCHARDUS		E. ENCRASICHOLUS		Total Pelag. Biomass (Sprats & O.P.S.) (Tons)
			Estimates (Tons)	Catches (quintals)	Estimates (Tons)	Catches (quintals)	
1976	June	Acou. Surv. area: 8,456	57,622	18,700	83,552	28,970	192,074
		Scaling up to: 29,511	204,430		296,424		681,436
1977	July	Acou. Surv. area: 9,934	118,253	33,080	100,940	33,520	288,424
		Scaling up to: 29,511	357,116		304,832		871,021
1978	Feb.	Acou. Surv. area: 3,845	29,490	3,230	255,334	23,900	859,625
		Scaling up to: 29,511	230,091		1,992,203		2,805,917
1980	July	Acou. Surv. area: 7,099	47,890	20,080	191,107	62,570	348,290
		Scaling up to: 29,511	202,381		807,608		1,471,855
Biomass averaged in the period: 1976/80		Biomass scaled up to the total area occupied by the stocks: 29,511	MIN. = 0.21 millions tons	MIN. = 0.30 millions tons	MIN. = 0.70 millions tons		
			AV. = 0.25 millions tons	AV. = 0.83 millions tons	AV. = 1.50 millions tons		
			MAX. = 0.36 millions tons	MAX. = 1.90 millions tons	MAX. = 2.80 millions tons		

TAB. 1: Summary of the preliminary results of acoustic surveys. The results are compared with the commercial catches taken inside the surveyed area during the survey period and they are scaled up to the probable total area occupied by the stocks.



Figure 1: Strategy of survey carried out in June 1976.

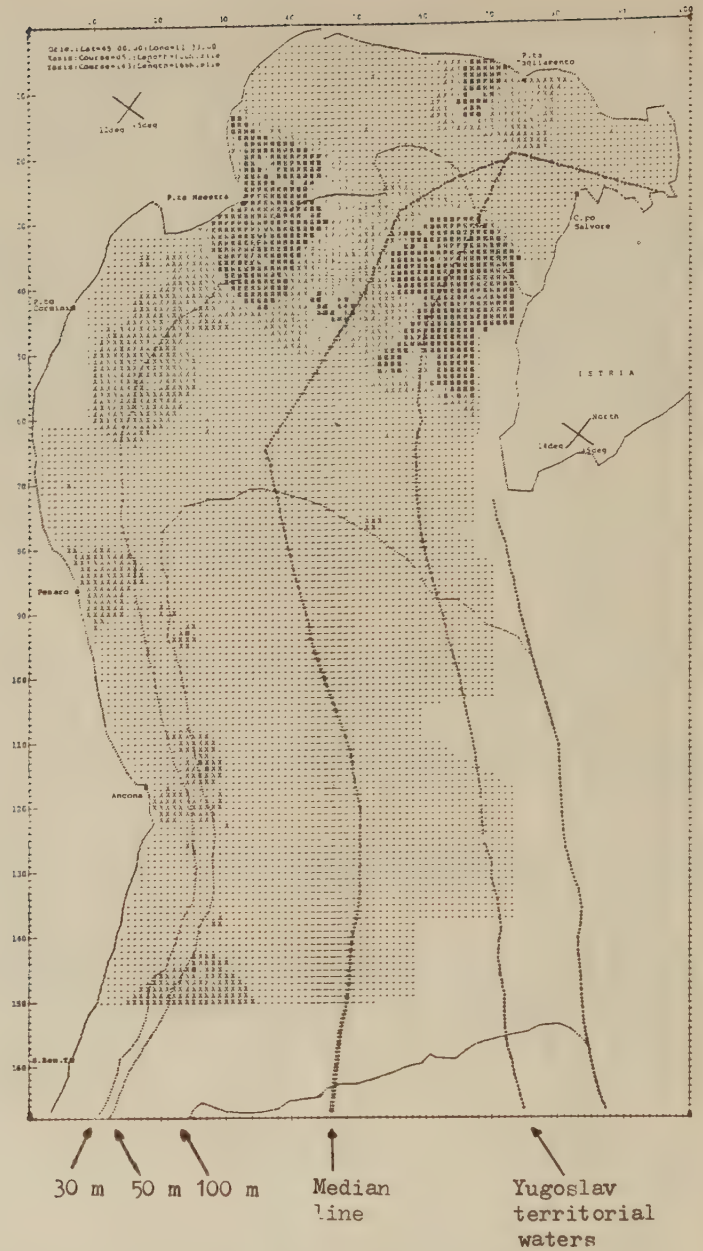


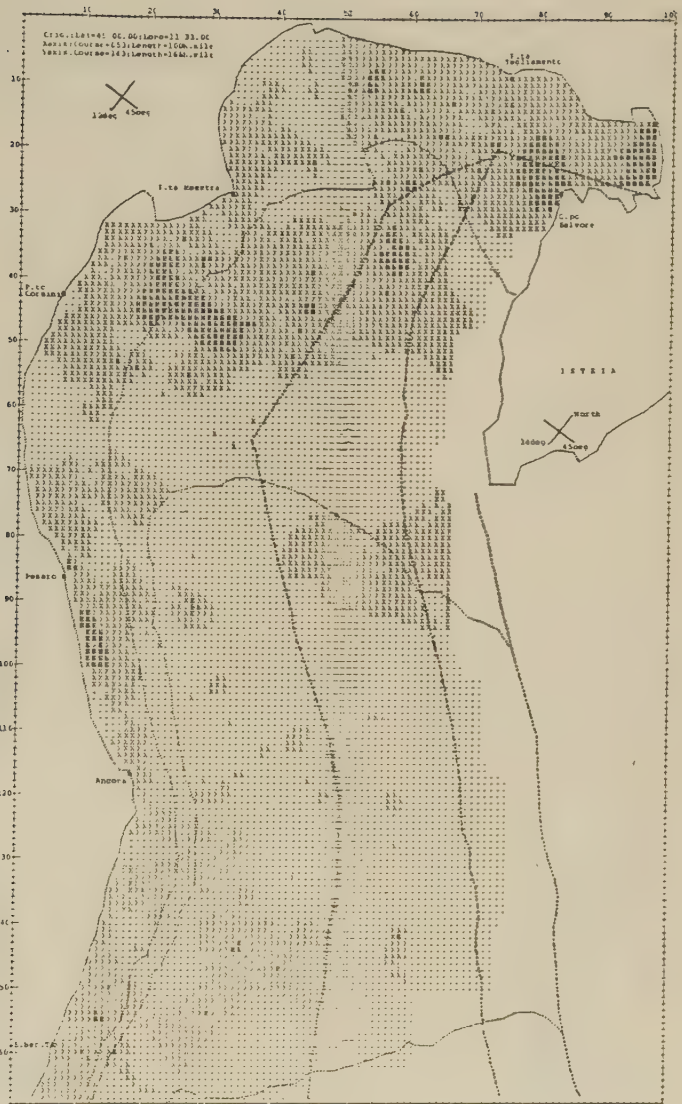
Figure 2: Distribution of pelagic biomass (June 1976) inside the surveyed area (8456 square n mile):

Anchovy:	43.5%	83552 tons
Sardines:	30.0%	57622 tons
Sprats & O.P.S.:	26.5%	50900 tons



SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
1	Survey track	2	Survey track
3	Survey track	4	Survey track
5	Survey track	6	Survey track
7	Survey track	8	Survey track
9	Survey track	10	Survey track
11	Survey track	12	Survey track
13	Survey track	14	Survey track
15	Survey track	16	Survey track
17	Survey track	18	Survey track
19	Survey track	20	Survey track
21	Survey track	22	Survey track
23	Survey track	24	Survey track
25	Survey track	26	Survey track
27	Survey track	28	Survey track
29	Survey track	30	Survey track
31	Survey track	32	Survey track
33	Survey track	34	Survey track
35	Survey track	36	Survey track
37	Survey track	38	Survey track
39	Survey track	40	Survey track
41	Survey track	42	Survey track
43	Survey track	44	Survey track
45	Survey track	46	Survey track
47	Survey track	48	Survey track
49	Survey track	50	Survey track
51	Survey track	52	Survey track
53	Survey track	54	Survey track
55	Survey track	56	Survey track
57	Survey track	58	Survey track
59	Survey track	60	Survey track
61	Survey track	62	Survey track
63	Survey track	64	Survey track
65	Survey track	66	Survey track
67	Survey track	68	Survey track
69	Survey track	70	Survey track
71	Survey track	72	Survey track
73	Survey track	74	Survey track
75	Survey track	76	Survey track
77	Survey track	78	Survey track
79	Survey track	80	Survey track
81	Survey track	82	Survey track
83	Survey track	84	Survey track
85	Survey track	86	Survey track
87	Survey track	88	Survey track
89	Survey track	90	Survey track
91	Survey track	92	Survey track
93	Survey track	94	Survey track
95	Survey track	96	Survey track
97	Survey track	98	Survey track
99	Survey track	100	Survey track

Figure 3: Survey strategy (July 1977).



SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
1	Survey track	2	Survey track
3	Survey track	4	Survey track
5	Survey track	6	Survey track
7	Survey track	8	Survey track
9	Survey track	10	Survey track
11	Survey track	12	Survey track
13	Survey track	14	Survey track
15	Survey track	16	Survey track
17	Survey track	18	Survey track
19	Survey track	20	Survey track
21	Survey track	22	Survey track
23	Survey track	24	Survey track
25	Survey track	26	Survey track
27	Survey track	28	Survey track
29	Survey track	30	Survey track
31	Survey track	32	Survey track
33	Survey track	34	Survey track
35	Survey track	36	Survey track
37	Survey track	38	Survey track
39	Survey track	40	Survey track
41	Survey track	42	Survey track
43	Survey track	44	Survey track
45	Survey track	46	Survey track
47	Survey track	48	Survey track
49	Survey track	50	Survey track
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53	Survey track	54	Survey track
55	Survey track	56	Survey track
57	Survey track	58	Survey track
59	Survey track	60	Survey track
61	Survey track	62	Survey track
63	Survey track	64	Survey track
65	Survey track	66	Survey track
67	Survey track	68	Survey track
69	Survey track	70	Survey track
71	Survey track	72	Survey track
73	Survey track	74	Survey track
75	Survey track	76	Survey track
77	Survey track	78	Survey track
79	Survey track	80	Survey track
81	Survey track	82	Survey track
83	Survey track	84	Survey track
85	Survey track	86	Survey track
87	Survey track	88	Survey track
89	Survey track	90	Survey track
91	Survey track	92	Survey track
93	Survey track	94	Survey track
95	Survey track	96	Survey track
97	Survey track	98	Survey track
99	Survey track	100	Survey track

Figure 4: Distribution of pelagic biomass (July 1977) inside the surveyed area (9934 square n mile):

Anchovy:	35%	100940 tons
Sardines:	41%	118253 tons
Sprats & O.P.S.:	24%	69321 tons



Figure 5:

Survey strategy (February 1978). The survey extended to Pescara (out of map) and was designed mostly to assess anchovy stock in winter season.

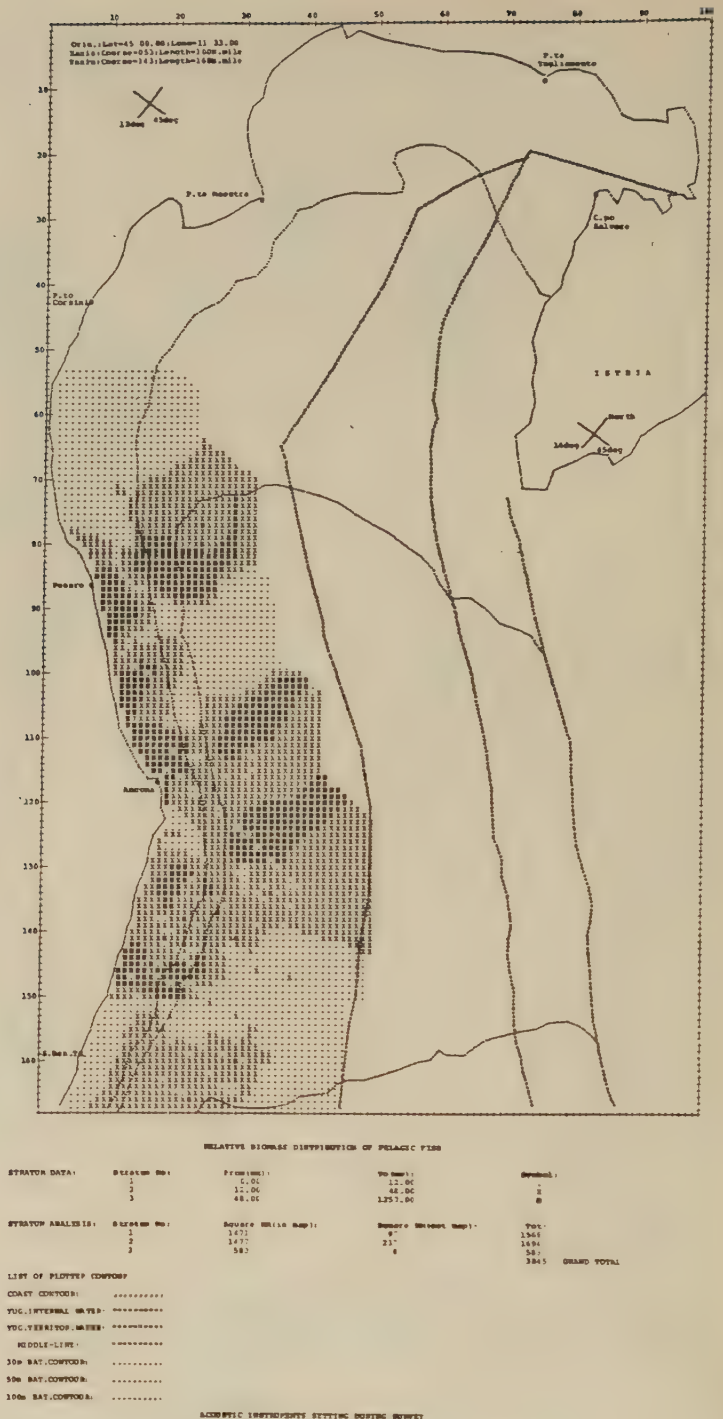


Figure 6: Distribution of pelagic biomass (February 1978) inside the surveyed area (3845 square n mile), that extends up to Pescara (out of map):

Anchovy:	71 %	255334 tons
Sardines:	8.2%	29489 tons
Sprats & O.P.S.:	20.8%	74802 tons

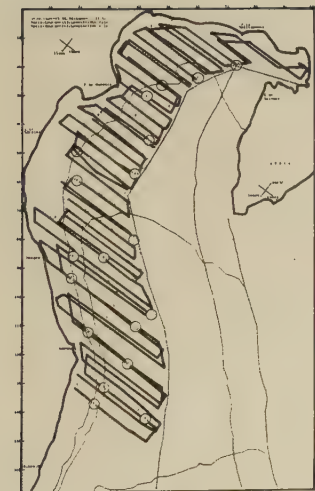
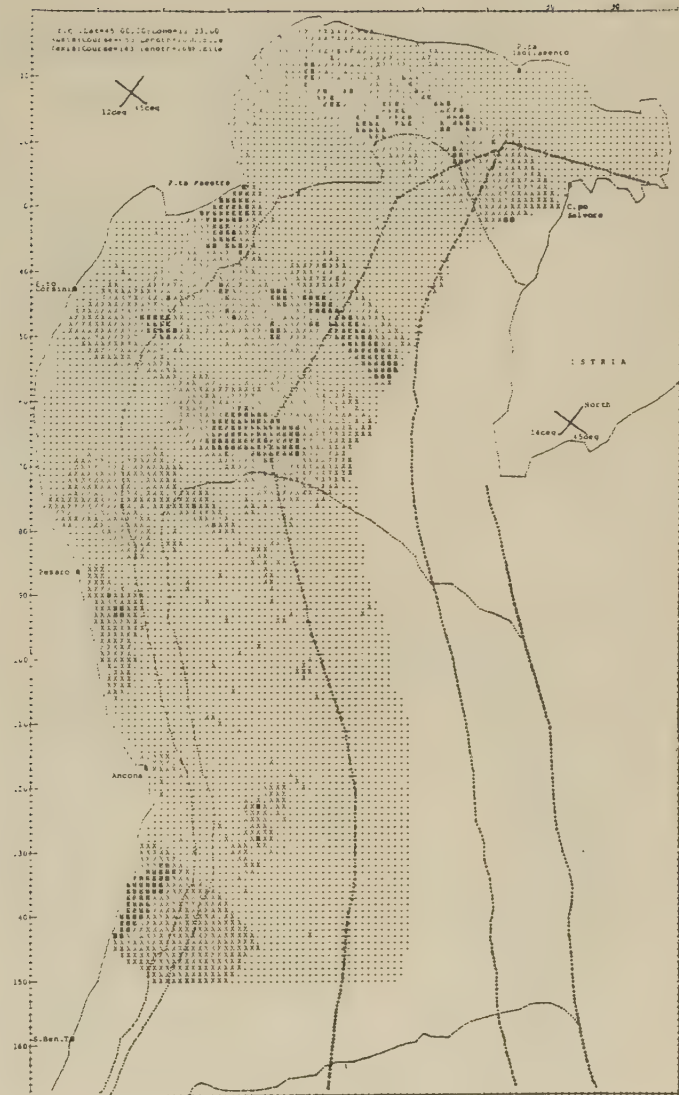


Figure 7:

Strategy of survey (July 1980) and distribution of biological stations ("B") inside the surveyed area.



RELATIVE BIOMASS DISTRIBUTION OF PELAGIC FISH				
STRATUM DATA:	Stratum No:	From (km):	To (km):	Symbol:
	1	0.00	45.00	1
	2	45.00	255.00	2
	3	255.00	1400.00	3
STRATUM ANALYSIS:	Stratum No:	Square km (10 km)	Square km (100 km)	Total
	1	4614	0	4614
	2	7100	0	7100
	3	577	0	577
				7099 GRAND TOTAL

LIST OF PLOTTER COORDINATES
 COAST COORDINATE:
 VIC. INTERNAL WATER:
 VIC. TIPPING WATER:
 PLOTTER NAME:
 30m BAT. COORDINATE:
 50m BAT. COORDINATE:
 100m BAT. COORDINATE:

TRANS. TYPE: 38-26/12-8
 YEAR: 1980

ACoustic INSTRUMENTS SETTING INSTRUMENTS
 E.S. 3A
 PULSE 1.40, 1.40

E.S. OR
 G.13-1000

Figure 8:

Distribution of pelagic biomass (July 1980) inside the surveyed area (7099 square n mile).

Anchovy: 58.87% 191107 tons (Av. length: 12.58 cm)
 Sardines: 13.75% 47890 tons (Av. length: 15.14 cm)
 Sprats 31.38% 109293 tons
 & O.P.S.:

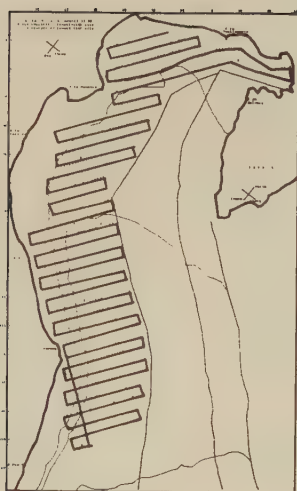
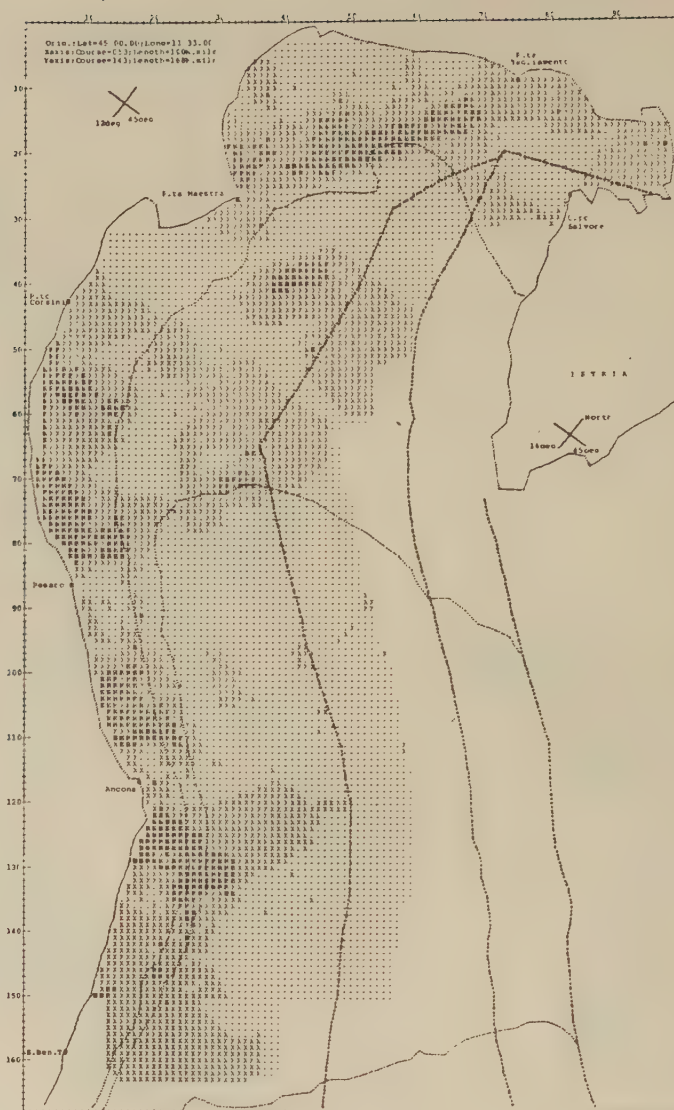


Figure 9:
Strategy of survey
(September 1981).



RELATIVE BIOMASS DISTRIBUTION OF PELAGIC FISH				
STATUS DATA:	Station No:	From (m):	To (m):	Species:
	1	0-01	246.01	1
	2	196.01	352.01	2
	3	352.01	736.01	3
STATUS ANALYSIS:	Station No:	Square Miles (sq. mi):	Square Miles (sq. mi):	Total:
	1	19.2	1	19.2
	2	27.5	2	27.5
	3	65.8	3	65.8
LIST OF PLOTTER CORRECTIONS				
CART CORRECTIONS:				
YUC: INTERNAL NOTES:				
YUC: TYPING NOTES:				
PLOTTER CORRECTIONS:				
300 PSI CORRECTIONS:				
500 PSI CORRECTIONS:				
1000 PSI CORRECTIONS:				
ACQUATIC METROPOLES SETTING DURING SURVEY				
TRANSMITTER: 38-26/22-4				
REAR: RAPID				
E.A. 300				
PULSE: 1-0.500				
E.A. 100				
GRAND TOTAL				

Figure 11: Distribution of pelagic biomass
(September 1981) inside the surveyed area
(7364 sq. n mile). The data on absolute
biomass, per species, is not yet available.

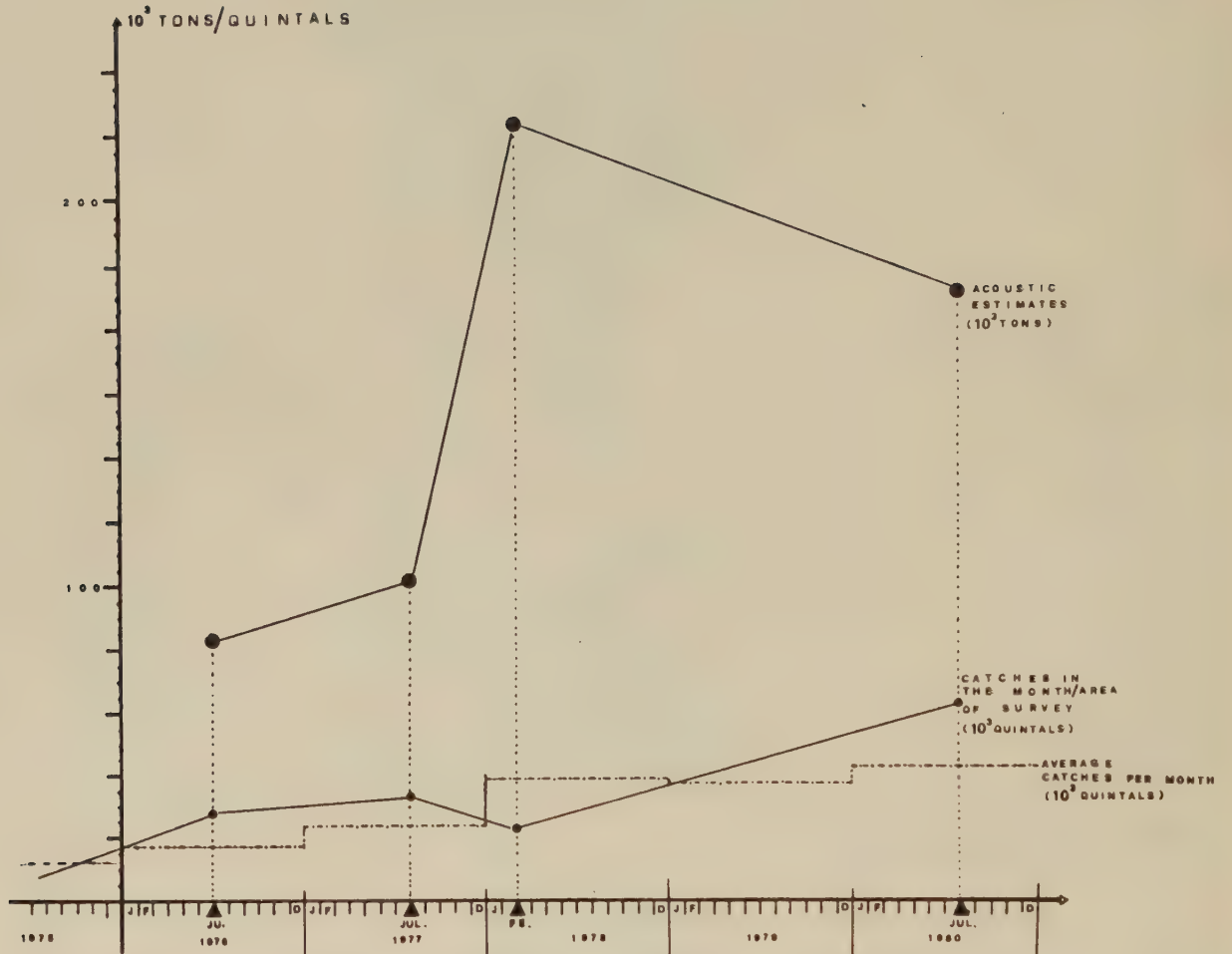


FIG.13: Graphic illustration of acoustic estimates of ANCHOVY biomass (●) observed in the surveyed area, catches (●) in the month and area of acoustic survey, average catches per month (---) in the total area from Triest gulf to Ancona.

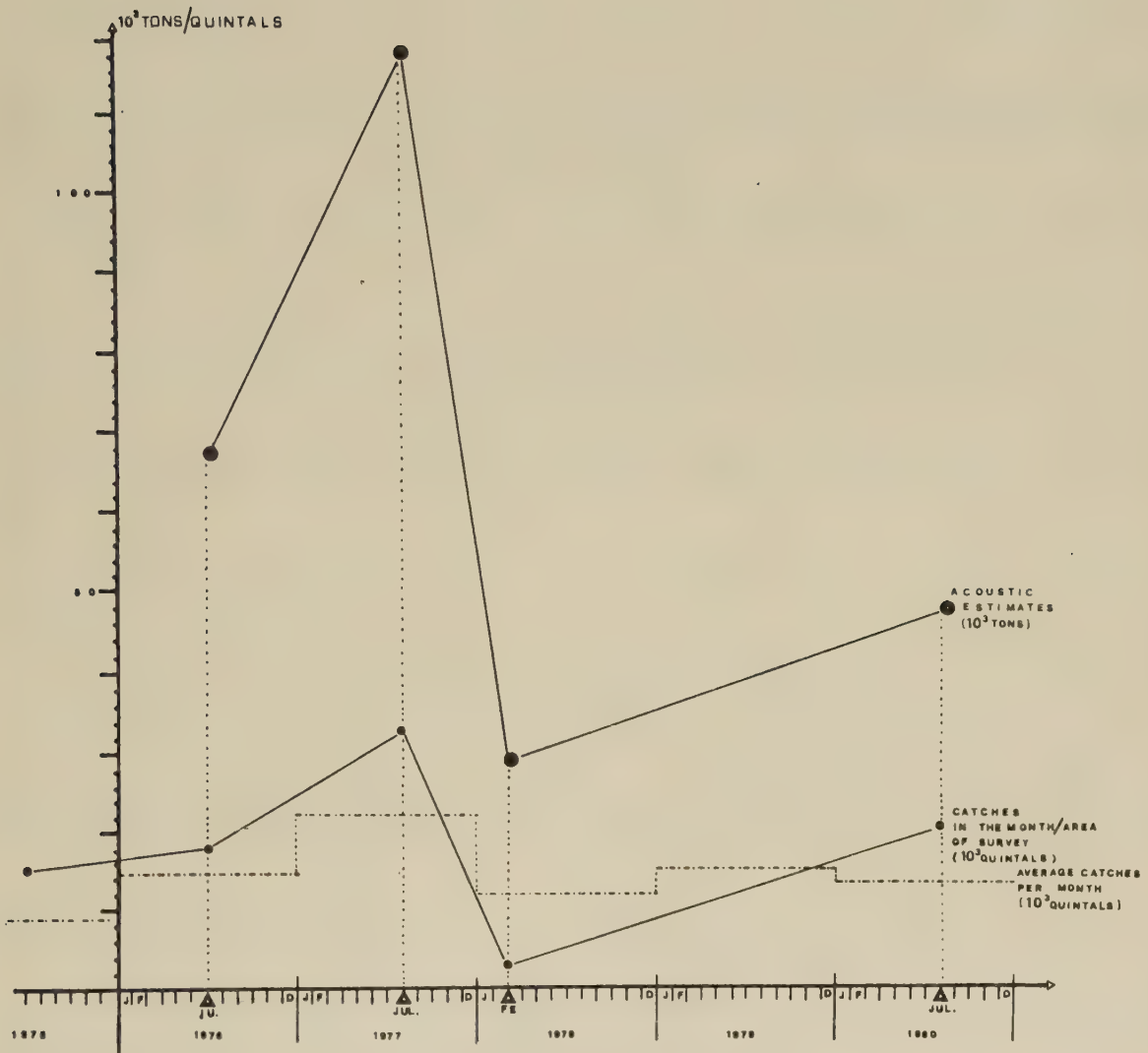


FIG.14: graphic illustration of acoustic estimates of SARDINES biomass (●), observed in the surveyed area, catches (●) in the month and area of acoustic survey, average catches per month (---) in the total area from Trieste gulf to Ancona.

ANNEXE GG / APPENDIX GG

Distribution and quantity of small pelagic fish in the Eastern Adriatic -
Comparison of results

by

I. Kacić

Institute of Oceanography and fisheries - Split, Yugoslavia

An echo survey for the assessment and distribution of small pelagic fish was carried out in June 1982 by R/V "Bios".

It covered the channel area of the middle Adriatic and open sea waters from the Susak island to Koper (Figure 1). The survey met a lot of difficulties due to the poor conditions of the research vessel and bad weather. A part of the Adriatic out of the Yugoslav territorial waters, from Porer Cape to Savudrija in Istrian waters, was also surveyed.

Results of some earlier investigations (Kacić, 1980; 1981) of relative and absolute abundance of small pelagic fish were compared with the results of the 1982 survey.

Middle Adriatic

Mean fish concentration number per unit survey (x/Nm) was 1.27 in the middle Adriatic; this exceeded by 0.59 the 1975 - 1977 concentration. Mean echo trace abundance of fish concentration (x/M) was 1.13 in 1982, i.e. 0.14 less than in 1977 (Table 1).

Decrease in the number of traces per unit survey (1 Nm) is relatively small; it may be concluded that no significant decrease in number of pelagic fish concentrations was recorded at the time of our survey.

Northern Adriatic

Mean echo trace abundance of fish concentration was slightly reduced in 1977 and 1982 in relation to 1975. (Table 1).

Fish concentration density (T/Nm^2) was, however, about $4T/Nm^2$ lower than in 1977 (Table 3).

Densities and quantities by areas (Table 2) indicate that a major part of population was still distributed in the western Istrian area, particularly in the Gulf of Trieste.

The comparison of the tables presenting the catch of three principal Adriatic pelagic fish species shows that in 1977 sardine catch increased while anchovy and sprat catch decreased (Table 4). Catch of all three species increased in 1982, particularly that of sprat, by almost 50 percent.

Catch increase of these species has already been reported on and accounted for (Alegria-Hernandez, 1981). Introduction of new fishing techniques, greater fish abundance and favourable meteorological conditions are the probable causes of this increase.

The echo survey showed slight reduction in the mean echo trace abundance of concentration per unit survey (x/M) and somewhat greater reduction in weight. However, no greater fish catch reduction is likely to occur since maximum fish concentration was very high, even 4.9. fish concentrations per length mile (Max/M) in some of the surveyed areas in the eastern Adriatic. This is particularly applicable to some channel areas of the middle Adriatic.

Generally speaking, fish distribution ranges have not changed in relation to the earlier established ones.

Echo survey data seem to be in agreement with the data on the distribution of eggs and larvae of pelagic fish species, especially sardine, since the number of sardine eggs and larvae also showed a slight decrease (Regner, personal communication). This drop, however, was not drastic and small pelagic fish catch is likely to be pretty high in 1983, as well.

References

Alegria-Hernandez, V. Assessment of pelagic fish abundance along the eastern Adriatic coast with 1981 special regard to sardine (*Sardina pilchardus* Walb.) population. Ph.D. Thesis, 154 p.

Kacić, I. Pelagic fish in the Adriatic. Distribution and stock assessment. FAO Fish.Rep., (239):21-31. 1980

_____ Pelagic fish in the northern Adriatic. Distribution and movements. FAO Fish.Rep., 1981 (253):131-6.

Table 1: Comparison of abundance of small pelagic fish (number of fish concentrations) during echo - monitoring in 1974-75, 1977 and 1982. (Max/M = maximal number of concentrations, $\bar{X}/M$ = average number of concentrations per mile of the crossed path).

Area of research	Year	Miles crossed	Number of fish concentrations				Abundance		Differences
			I	II	III	T	Max/M	$\bar{X}/M$	
Middle Adriatic	1974-75	1704	856	187	73	1121	3,1	0,68	+ 0,59 - 0,14
	1977	215	174	81	19	274	3,3	1,27	
	1982	221	163	72	15	250	2,9	1,13	
North Adriatic	1974-75	2351	2274	881	465	3620	5,4	1,58	- 0,12 - 0,04
	1977	267	253	104	32	389	5,8	1,46	
	1982	283	270	98	94	402	4,9	1,42	

Table 2: Quantity and density of small pelagic fish obtained by scientific sounder and echointegrator in the Middle and North Adriatic in 1982

Area	Area surveyed (S) (Nm ²)	Echointegrator Mv mm/Nm canals A B (A+B)	Density (d)	Weight (W) (W) in tons
Bracki K.	1566			
Neretvanski K.				
1. Korculanski K.	1566	0,30 2,75 3,05	56,12	53033
Pelegrin				
2. Solta	64	0,19 0,89 1,08	19,90	1274
Primošten				
3. Kornati	985	0,15 0,79 0,94	17,29	17030
Porer				
4. Novi grad	589	0,86 1,78 2,64	48,57	28608
Novi grad				
5. Tršćanski Z.	336	1,25 2,21 3,46	65,66	22061
Tršćanski Z.				
6. Porer	1659	0,20 2,09 2,20	42,32	70209
Kvarner				
Biograd				
Primošten				
Whole area	4578	0,49 1,76 2,26	41,64	192216

Table 3: Quantity and density of small pelagic fish obtained by scientific sounder and echointegrator in the Middle and North Adriatic in 1977 and 1982

Year	Area surveyed (S) Nm ²	Echointegrator canals A B	(nVmm/Nm) (A+B)	Density (d) T/Nm ²	Weight (W) in tons
1977	1925	0,62	1,87	2,48	87972
1982	4578	0,49	1,76	2,26	192216

Table 4: Catch of small pelagic fish in the Yugoslav part of the Adriatic from 1975 to 1982

Year	Catch (in tons)		
	Sardine	Anchovy	Sprat
1975	18596.0	2863.1	2437.3
1976	21559.1	2529.3	2363.2
1977	22763.7	1836.5	2050.4
1978	22244.0	2744.0	3814.0
1979	18512.0	2062.0	5206.0
1980	19704.0	2213.0	4300.0
1981	31487.0	2390.0	2626.0
1982	25731.0	2229.0	4010.0



Figure 1: Surveyed area (hachured) in June 1982.

ANNEXE HH / APPENDIX HH

Estimate of spawning biomass of sardine in the Northern and Central Adriatic from 1979 to 1982 by means of egg surveys

by

Slobodan Regner
Institut za oceanografiju i ribarstvo, Split

Corrado Piccinetti
Laboratorio di Biologia Marina e Pesca, Fano

Mario Specchi
Istituto di Zoologia, Università di Trieste, Trieste

1. INTRODUCTION

Sardine stock assessment from egg surveys in the Adriatic has been carried out ever since the spawning season of the years 1978/79. The egg surveys were made in the area which covered northern, central and a part of southern Adriatic, from the Gulfs of Venice and Trieste up to the line connecting Monte Gargano and cape Ostra at the entrance of Boka Kotorska, at the surface of 101 219 km² or 29 511 Nm². The results of stock assessments for the spawning seasons of the year 1978/79 and 1979/80 have already been published (Piccinetti *et al.*, 1980; Regner *et al.*, 1981), as well as the methods for statistical analysis of the error in the estimation of the number of sardine eggs produced under 1 m²/day during the surveys (Regner *et al.*, 1981).

The aim of this paper is to present the results of sardine stock assessments for one entire period of surveys, to discuss the influence of the curves of spawning intensity on the error in stock assessments, and to estimate maximum sustainable yield on the basis of the estimated spawning biomass.

2. MATERIAL AND METHODS

The biomass of the mature fish can be estimated from the equation:

$$\hat{B} = \frac{\hat{E}}{F_r} (1 + R) \quad (1),$$

where $\hat{B}$ is the estimated biomass, $\hat{E}$ estimated total number of eggs produced during the spawning season over the surveyed area, F_r relative fecundity, and R sex ratio.

To obtain the value of E six cruises (one or two per spawning season) over the surveyed area were done. During the cruises plankton was sampled by double - oblique hauls of Bongo - 20 plankton net which was equipped with flow and depthmeter. For every cruise the mean number of sardine eggs under 1 m² per day was calculated. The method of these calculations was described in previously published paper (Regner *et al.*, 1981). Number of stations per cruise varied from 37 to 92.

The intensity of spawning was monitored at three stations in the central Adriatic throughout the spawning seasons.

Data on relative fecundity of sardine, F_r in equation (1), were taken from Sinovčić and Alegria (1982), who found relative fecundity to be 944.4 eggs per gram of female. The value of two standard errors of the relative fecundity is ± 49.48 .

The sex ratio, according to a number of authors, was accepted to be 1, so that the value of $(1 + R)$ in equation (1) was 2.

3. RESULTS

(a) Estimates of quantity of sardine eggs produced during the cruises.

Results obtained from all six cruises during the period of investigations are given in Table 1.

As it could be seen from Table 1, the confidence limits for the significance level of 95 % are relatively wide, ranging from 53.19 to 84.79 %.

Table 1. Estimates of the mean production of sardine eggs under 1 m² per day for six cruises made during the spawning seasons from 1978/79 to 1981/82. ($\bar{X}$ = mean number of eggs/m²; $\bar{D}$ = mean time in days needed for the complete development of eggs; $\bar{m}$ = mean instantaneous mortality rate; $\bar{Y}$ = mean number of eggs/1 m²/day).

Spawning season	Cruise	N ^o of stations	$\bar{X}$	$\bar{D}$	$\bar{m}$	$\bar{Y}$	Confidence limits (P 0.05) $\pm$ %
1978/79	February-March	64	20.39	4.41	0.5441	12.02	53.19
1979/80	December-January	79	38.47	3.48	0.7430	25.45	53.32
	February	92	47.37	4.48	0.3391	22.65	84.79
1980/81	March-April	82	39.73	3.70	0.5591	22.62	59.73
1981/82	December	37	24.05	4.14	0.9939	33.81	55.73
	March-April	78	30.57	4.28	0.3821	12.37	58.86

As mentioned before (Regner et al., 1981), it seems that the variance of the spatial distribution of sardine eggs is in positive correlation with the number of stations per cruise. For these six cruises the coefficient of correlation between the number of stations and the total variance of spatial distribution of eggs was $r = 0.554$ (n.s.).

The variability of instantaneous mortality rate was high, with the mean value of $m = 0.5936$ and with the coefficient of variability $V = 40.97\%$. In general, mortality rates found during the cruises made in December-January were greater than those from March-April.

(b) Analysis of the curves of spawning intensity

The material for the analysis of spawning intensity during the spawning seasons was collected from three stations situated at the profile at the level of Split. The first station is in the Bay of Kaštela ($43^{\circ} 31' N 16^{\circ} 22' E$), in the typical inshore waters of the eastern Adriatic coast which are strongly affected by the mainland. The second one ($43^{\circ} 12' N 16^{\circ} 19' E$) is situated near the cape Pelegrin of the island Hvar, in the channel area of mid-Dalmatian islands, while the third one ($43^{\circ} 00' N 16^{\circ} 20' E$) is near cape Stončica of the island Vis, under the influence of the open sea.

The curves from all four spawning seasons and all the stations are polymodal with two maxima. First maximum appears in November or December, and the second one in March or April.

The cumulative frequencies were calculated for the mean number of eggs for every month of the spawning seasons from 1978/79 to 1981/82. They show that the curves of sardine spawning intensity, going from the inshore waters to the open sea, approach the normal distribution (figure 1).

But, even at the station Stončica, cumulative frequencies show the mixture of two normal distributions. This indicates that spawning intensity decreases over the whole profile, mainly in January and February. This is particularly marked in the coastal waters of the Bay of Kaštela.

The most probable cause of bimodality of spawning curves is that major part of adult sardines during the spawning season leave the coastal waters of the central Adriatic and migrate towards the open sea (Muzinić, 1973). This migration of mature sardine, particularly from the Bay of Kaštela, seems to be very well reflected on the shapes of the spawning curves. For that reason, spawning curves from the Bay of Kaštela are not convenient for the calculation of total production of sardine eggs over the area covered by cruises.

This was the reason why only the mean values from the stations Stončica and Pelegrin were used for the integration of the mean number of eggs obtained from the cruises over the spawning curves. But, nevertheless the four spawning seasons means from these stations approach the normal distribution (figure 1), every single spawning curve shows bimodality although less pronounced than those for the Bay of Kaštela.

It can be supposed that even a part of fish from channel and open sea areas near the mid-Dalmatian islands migrate towards one of the spawning centers, which are located between the island of Palagruža and Monte Gargano and in the area between Dugi Otok and Ancona (Gamulin, 1954; Serivanić and Zavodnik, 1973; Piccinetti et al., 1981).

If such migration patterns are real, the monomodal curve of spawning intensity, with the normal distribution of frequencies, is to be expected within the centers of spawning. In that case, even the spawning curves from the stations Stončica and Pelegrin are not reliable enough for the estimation of the total number of eggs produced during the spawning season. Moreover, it seems that the use of these curves leads to a considerably large error.

It has to be mentioned that, for this moment, there is no other way for such estimations, but in the future assessments some other solutions should be found.

Mean numbers of eggs/1 m²/day obtained by cruises were integrated over the spawning intensity curves by planimetry. The surface obtained by measuring the area under the spawning curve which was covered by cruise (shaded area in figure 2), was divided by surface under the entire curve:

$$\frac{p}{P} = r$$

Number of eggs which was estimated to be produced during the period of cruise was divided by value of r to obtain the total number of eggs produced under 1m² during the spawning season. The number of eggs produced during the cruise was estimated by summation of corrected values going right and left from the mid-point of the cruise period ($m_L \dots m_R$ in figure 2).

The following quantities of eggs produced under 1 m² during the spawning seasons were estimated in this way:

Spawning season	Cruise	No of eggs/1m ² /season
1978/79	February-March	2 288.71
1979/80	December-January	2 667.55
	February	8 241.14
1980/81	March-April	6 107.30
1981/82	December	3 883.54
	March-April	6 228.17

It is evident from these data that the estimated numbers of eggs in the cases when two cruises were done are very different. Number of eggs estimated for the spawning season 1979/80 from the cruise made in December-January makes only 32.37 % of the number estimated from the February-March cruise. Similarly, the number of eggs estimated for the 1981/82 spawning season from December cruise makes 62.35 % of that of March-April. Furthermore, it is evident that estimates obtained from the cruises which coincide with the maxima of spawning are always smaller than estimates from the cruises which covered the periods of less intensive spawning (spawning seasons 1979/80 and 1981/82 in figure 2).

This is one more indication that the curves of spawning intensity obtained from the monitored profile are not relevant enough for the estimation of the total number of sardine eggs over the area covered by cruises. Moreover, as the probable differences between the spawning curves within the spawning centers and the monitored profile are not known, the magnitude of possible error cannot be estimated.

This problem may be overcome in future surveys in two ways: the first one is to make the monitoring profiles across the sardine spawning centers, and the second one to make more cruises, four or five at least, during the spawning season.

Multiplying the total number of eggs produced under 1 m² during the spawning season by the surface covered by cruises, the following total quantities of eggs produced by sardine are estimated:

Spawning season	$\hat{E}$	Confidence limits ($P < 0.05$)
1978/79	$2.317 \cdot 10^{14}$	$\pm 53.19 \%$
1979/80	$5.521 \cdot 10^{14}$	$\pm 69.06 \%$
1980/81	$6.182 \cdot 10^{14}$	$\pm 59.73 \%$
1981/82	$5.117 \cdot 10^{14}$	$\pm 58.86 \%$

The confidence limits of $\hat{E}$ are calculated only for the variability of spatial distribution, while the errors arising from the integration over the spawning intensity curves, as it was shown above, could not be estimated.

(c) Estimates of spawning biomass of sardine

When the data on $\hat{E}$ and F_r , as well as their confidence limits, were substituted in equation (1), the estimates of biomass of sardine were found to be as follows:

Spawning season	$\hat{B}$ (tons)	Confidence limits ($P < 0.05$)	
		lower ($\hat{B}_{min}$)	upper ($\hat{B}_{max}$)
1978/79	490 599	218 253	793 235
1979/80	1 169 173	343 743	2 085 952
1980/81	1 309 137	500 943	2 206 701
1981/82	1 083 754	423 651	1 828 319

Table 1: Biomass estimates.

Generally, the confidence limits of the estimates vary within the limits of $\pm 59\%$, the error of the integration over the curves of spawning intensity not included.

Although the errors caused by the variability and/or the differences in spawning intensity between the monitored profile and the areas of the most intensive spawning could not be estimated, the estimates of biomass seem to be real to some extent. This may be supposed from very good correlation between estimated biomass and annual Yugoslav catch of sardine, as it is shown in figure 3.

The coefficient of correlation between Yugoslav catch of sardine and the absolute estimates of biomass (B) was $r = 0.699$, while with the lower 95 % significance levels ($B_{\min}$) it was $r = 0.931$.

(d) Preliminary estimates of maximum sustainable yield (MSY)

The first preliminary estimate of maximum sustainable yield of sardine, based on data on spawning biomass obtained from egg surveys, was done by Piccinetti *et al.* (1981a) for the years 1979 and 1980. In that paper Schaefer's (1954) model, modified by Gulland (1971), was used, which assumes that:

$$MSY = XMB_0 \quad (2),$$

where MSY is the maximum sustainable yield, M the natural mortality coefficient, B_0 the virgin biomass, and X a constant. In that estimate the approximative value of M was taken from the model of Rikhter and Effanov (1976), and it was found to be 0.55 for sardine.

For estimates of MSY in this paper we tried to use the data on mortality coefficients obtained from direct observations on Adriatic sardine. As there were no recently published data neither on growth parameters nor on the age structure of sardine in the Adriatic, we had to use data on age structure given by Mužinić (1954) for the open waters of central Adriatic, which have been collected during the years 1946-1952 (figure 69 in Mužinić, 1954). Total mortality coefficients of sardine (Z) were estimated by following the decrease in numbers of every single age class (from fifth year of life on) using the regression of the equation:

$$\ln N_{t_i + n} = \ln N_{t_i} - Zt \quad (3),$$

where $N_{t_i + n}$ is the number of individuals in $t_i + n$, N_{t_i} number of individuals before n time intervals, and t time in years. Following every separate age class the influence of possible changes in recruitment are avoided, while the start of calculations from the fifth age class on, covered age classes fully subjected to fishing.

It was found that the mean mortality coefficient was:

$$Z = 1.0126 \text{ with the standard deviation } s = 0.5795$$

The official statistical data on Yugoslav catch of sardine in the years 1979-1982, as well as data on Italian catch in 1979, were used to estimate the fishing mortality. Data on Italian catch in the years 1980-82 were not available, and we tried to estimate them. It was found that Italian and Yugoslav catch of sardine were in good correlation, with the phase lag of one year of Italian catch (Regner, manuscript). Italian catch can be estimated from the equation:

$$C_{it_{i+1}} = -14\,581.421 + 1.9888C_{yu_{t_i}} \quad (4),$$

where $C_{yu_{t_i}}$ is the Yugoslav catch in the previous year. The correlation coefficient is

$r = 0.908$; $P < 0.001$. Standard error of regression coefficient is $s_b = 0.3459$, and its upper and lower limits for 0.05 significance level are 2.8069 and 1.1707 respectively.

In order to be conservative, the upper limit of regression coefficient was used to estimate Italian catch and following results are obtained:

Year	Sardine catch in tons		Total
	Yugoslav	Italian	
1979	18 535	34 393 (real value)	52 928
1980	19 704	37 444	57 148
1981	31 484	40 726	72 213
1982	25 731	73 799	99 530

Table 2: Estimates of sardine catches

The rough estimate of fishing mortality coefficients (F) for every year was done from the expression:

$$F \sim \frac{C}{B},$$

where C is the catch, and B the estimated biomass.

M was estimated by subtraction of $F = \frac{C}{B}$ from Z estimated above from Muzinić data, the assumption being that the value of total mortality Z did not change much from the 1946/52 level.

The use of more than thirty years old data to estimate MSY is incorrect and makes the estimates of MSY extremely preliminary, but as it was said before they are the only data available. The main problem in use of these data is that, although it might be expected that natural mortality coefficients will vary within the long period of time around the certain mean, and that the period of 1946-52 is long enough to obtain reliable mean value of M, the fishing mortality coefficient might have substantially changed since then. It might be expected that the fishing mortality will be higher now than it was in period from 1946 to 1952, because during the sixties more efficient gears, as well as the echo-sounders and modern navigation equipment were introduced in Adriatic fishing fleets. In that case, if it is assumed that M is "constant" on the long term the value obtained for M in our procedure might be considered as an underestimate, as the estimates of MSY derived from it (see below). The following results are obtained:

Year	$C/\hat{B}_{\min}$		$C/\hat{B}$	
	F	M	F	M
1979	0.243	0.770	0.108	0.905
1980	0.166	0.847	0.049	0.946
1981	0.144	0.868	0.055	0.957
1982	0.235	0.778	0.092	0.921

Table 3: Estimates of F and M = Z-F

Calculating the value of X as suggested in Gulland (1971), it was found that X varies between 0.38 and 0.87 with the mean of 0.51. In order to use Gulland's equation an estimate of B_0 the virgin biomass is needed. Our estimates of Biomass (table 1); obtained for years where some fishing was going on are therefore underestimates of virgin biomass.

Substituting the values of X and M , as well as the estimated spawning biomass (instead of B_0), in equation (2), an underestimate of the maximum sustainable yield can be roughly obtained for each year. The results are:

Year	MSY ($\hat{B}_{min}$)	MSY ($\hat{B}$)
1979	85 708	226 436
1980	148 487	574 812
1981	221 757	638 950
1982	168 096	509 050

Table 4: Estimates of MSY.

A comparison of the estimates of MSY, even those obtained for lower 95 % confidence limits of biomass estimates ($\hat{B}_{min}$), and annual catches (table 2) show that sardine stock has not been fully exploited during the years 1979-82. On the other hand, even if the lower value of $M = 0.55$ (as calculated by Rikhter and Effanov's model in Piccinetti *et al.*, 1981a) is compared with the present estimates of F , it can be seen that $F \ll M$. This fact also indicates that stock was not fully fished, as it is generally assumed that $F \approx M$ when the yields are at levels close to MSY (Gulland, 1971).

Finally, it should be noted that sardine stocks in the Adriatic are affected by long term fluctuations in biomass not related to fishing. It is known that these changes are generally associated with insidious changes in catchability which may lead to overfishing, especially during the years of decreasing biomass. For that reason, continuous monitoring of sardine biomass and careful analysis of its population dynamics is needed.

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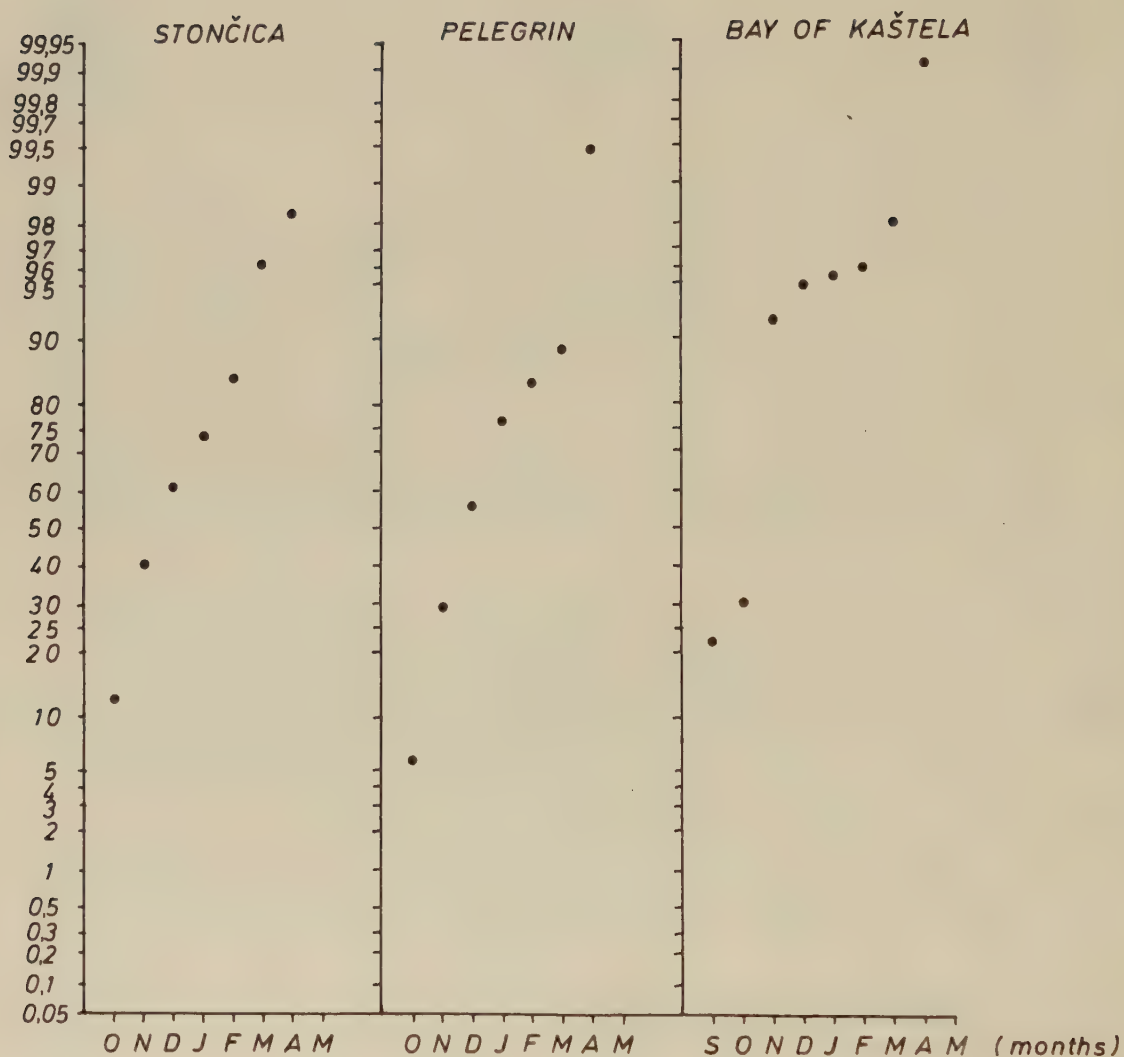


Figure 1: Cumulative frequencies of the four years means of sardine egg production at the monitored profile.

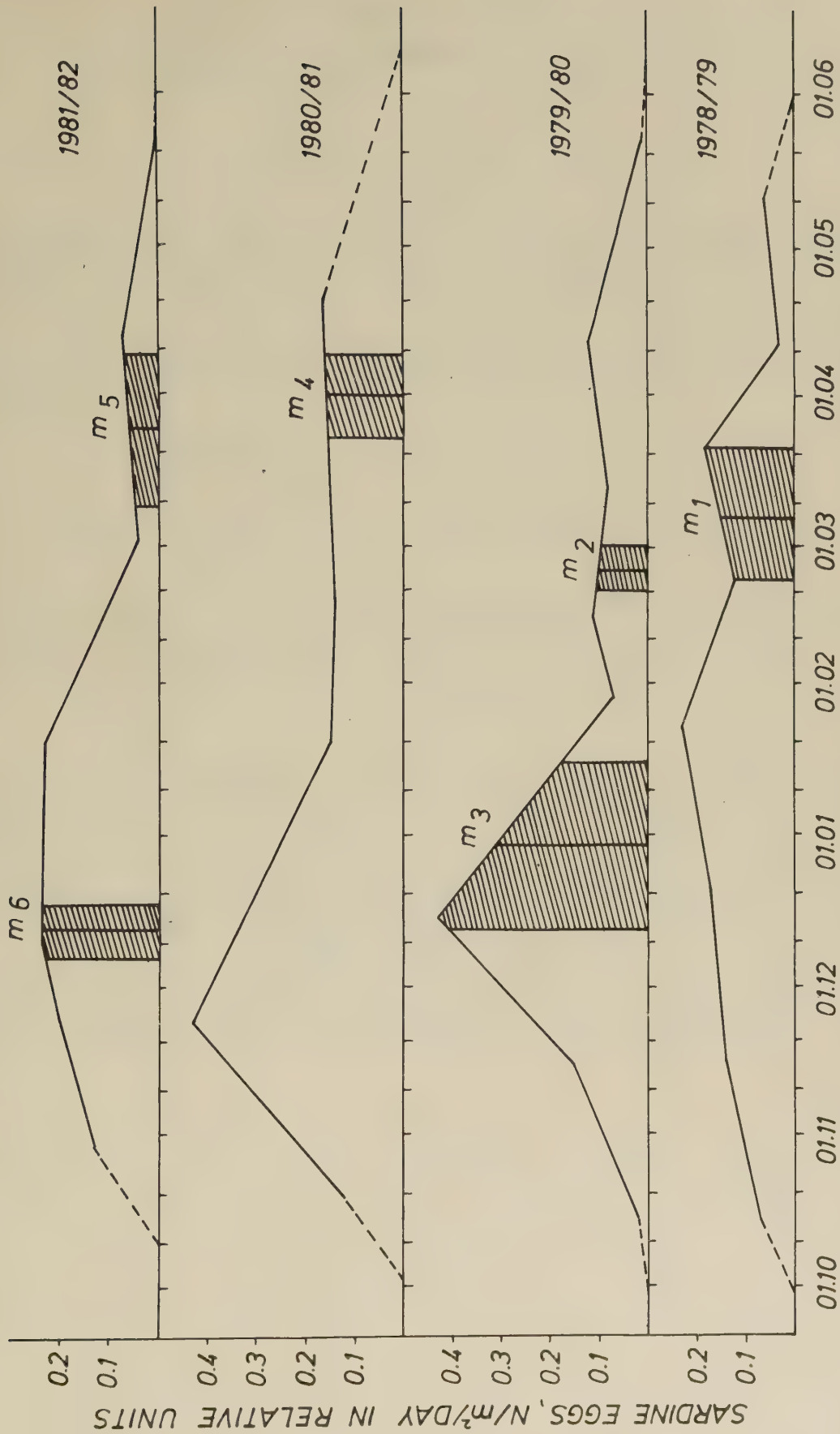


Figure 2: Curves of spawning intensity of sardine (monthly means of the stations Pelegrin and Stontica). Shaded area = period covered by cruises; m1.....m6 = midpoints of cruises.

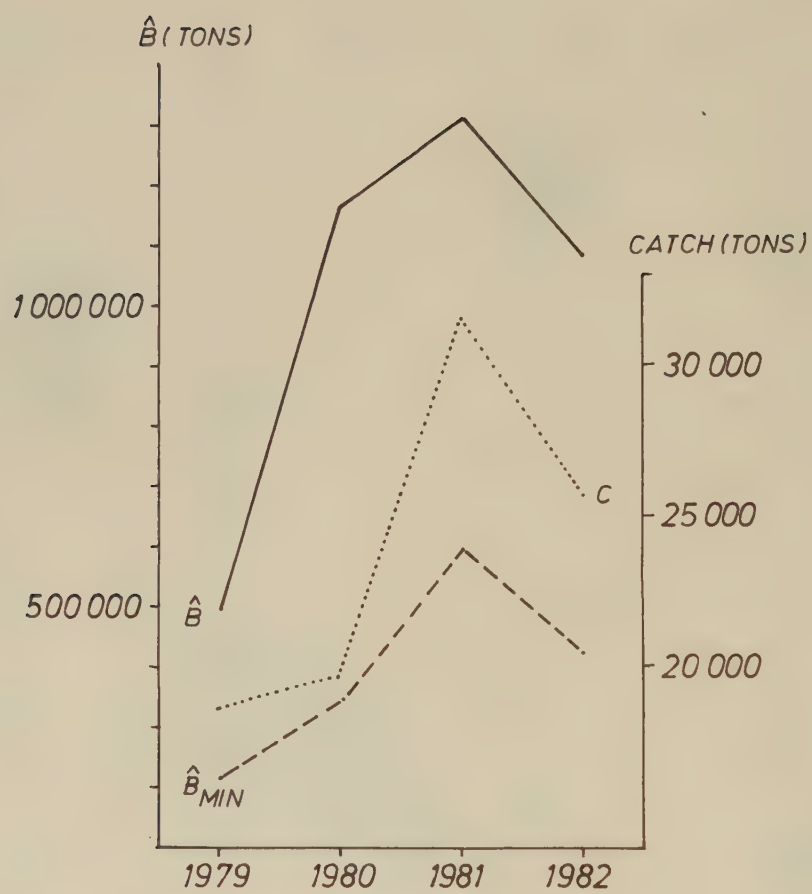


Figure 3: Relationship between estimated biomass and Yugoslav annual sardine catch.

ANNEXE II / APPENDIX II

Considérations sur la pêche du "Bianchetto" en Adriatique

par

M. Rizzoli

Laboratorio di Biologia Marina e Pesca - Fano, Italie

La pêche du "bianchetto", constitué principalement de formes juvéniles de clupéiformes, destiné à l'alimentation humaine, est traditionnelle en plusieurs zones d'Italie. Cette activité est autorisée pendant deux mois par an, et détermine un prélèvement de juvéniles, en particulier de sardines et d'anchois, qui pourrait influencer la dynamique des adultes.

Le Laboratoire de biologie marine et de pêche de Fano a été chargé par le Ministère de la Marine marchande d'étudier cette situation et a réalisé dans le golfe de Manfredonia, où cette pêche est particulièrement intense, des séries de sorties en mer avec des bateaux commerciaux déterminant pour chaque trait de chalut la composition spécifique et la quantité capturée de "bianchetto".

Dans le tableau 1 est reportée la quantité capturée au cours des différents mois, par trait de 30 minutes en moyenne et la répartition des espèces en pourcentage par poids.

La variabilité des captures pour chaque espèce en fonction de la saison est évidente; ceci reflète les différences de la biologie; en plus il y a bien sûr une grande variabilité en fonction de la zone de pêche et de l'année.

Dans le port de Manfredonia on pêche en moyenne 20 tonnes de "bianchetto" par jour de pêche (pour environ 200 bateaux) et on peut estimer à environ 700 tonnes la quantité de "bianchetto" capturée au cours de la période autorisée. Pendant les mois de janvier et de février les sardines représentent en moyenne 68 pour cent des captures, c'est-à-dire environ 480 tonnes.

Le poids moyen de 0,151 g pour chaque juvénile de sardine en janvier et en février conduit à chiffrer à $3,2 \cdot 10^9$ le nombre de sardines capturées à Manfredonia.

Si l'on considère la croissance en poids de chaque exemplaire et la mortalité naturelle très élevée avant d'arriver à la fin de la deuxième année, on obtient une quantité de sardine adulte très réduite qui, sur le plan économique, a une valeur bien inférieure à celle des juvéniles capturés comme "bianchetto". Il faut considérer que la biomasse de sardine adulte a été estimée en Adriatique à environ 1 000 000 de tonnes et que la pêche des adultes de cette espèce peut y être estimée à 100 000 tonnes. Il en résulte que la pêche au niveau actuel du "bianchetto" peut être compatible avec la conservation du stock de sardine; mais, en raison des fluctuations d'abondance de cette espèce et de la faible connaissance des unités de stocks, une attention particulière devrait être portée à ces problèmes avant de développer la pêche du "bianchetto".

Pour les autres espèces qui rentrent dans la composition du "bianchetto", leur capture a une incidence plus faible sur la pêche des adultes, en particulier pour l'anchois qui a une biomasse de quelques millions de tonnes en Adriatique.

Tableau 1: Quantités de "bianchetto" capturées selon les différents mois (grammes par 30 minutes) et pourcentages des espèces

ESPECES	Décembre g/30' %	Janvier g/30' %	Février g/30' %	Mars g/30' %	Avril g/30' %	Mai g/30' %	Juillet g/30' %
<u>Sardina pilchardus</u> (Walb.)	443 12,6	977 55,1	4750 82,5	80626 98,9	20598 66,7	12058 88,0	13 65,0
<u>Engraulis encrasicolus</u> (L.)	1125 32,0	220 12,4	477 8,3	829 1,0	9058 29,3	1080 7,9	- -
<u>Sprattus sprattus</u> (L.)	- -	- -	- -	- -	1137 3,7	425 3,1	- -
<u>Aphia minuta</u> (L.)	1943 55,3	577 32,5	530 9,3	83 0,1	87 0,3	132 1,0	7 35,0

ANNEXE JJ / APPENDIX JJ

A note on the fish fry fishing in the southern area of the Po River Delta

by

Remigio Rossi
Institute of Zoology, University of Ferrara, Italy

1. INTRODUCTION

Fry of catadromous fishes is always in great demand for aquacultural purposes in Italy, because in the north-western Adriatic coast there are numerous walled coastal lagoons in which natural recruitment is insufficient (Gandolfi *et al*, 1981). The estuaries, the harbours, the shallow near shore, all the bays, mainly of the Po River Delta, are, on the contrary, nursery grounds for fry of several euryhaline species.

This fact has favoured the development of a particular kind of fishing, made by specialized fishermen of Goro, Chioggia and Marano, along all the Italian Adriatic coasts and elsewhere, in order to restocking lagoons and fish-farms.

2. FISH FRY MIGRATIONS

The inwards migrations of fry in the Delta area (Rossi, 1983), display an abundance trend showing two seasonal peaks. The higher peak occurs in spring and is mainly supported by Liza ramada, L. saliens, Sparus aurata, Dicentrarchus labrax and flatfishes, such as Solea vulgaris and Platichthys flesus; the autumn peak by L. saliens and M. cephalus. Among the fry of grey mullets, L. saliens is constantly present, while L. ramada is the dominant species in March and L. aurata in April. M. cephalus and Chelon labrosus account for less than 1% of the total catches.

3. FISH FRY HARVESTING

This kind of fishing is regulated by a State rule: fishing season in the Adriatic starts at the end of March and stops at the middle of June. The allowed fishing gear is a beach seine net, with a little bag, 1 to 40 metres long, with a mesh size ranging from 1 x 1 to 4 x 4 mm., according to the dimensions of the fry to be gathered.

The following data regard the Goro fishery, which operates mainly in the Southern area of the Po River Delta. About 75 boats (2 or 3 fishermen per boat) work during the first two weeks, when the catch of the gilthead and mullets is abundant and profitable; later on 20-25 boats go on to work in April and May and only 4-5 till the middle of June.

Table 1 shows an estimate of the fish fry catch in the area. The fish fry inwards migration is characterized by wide number variations from year to year, due to the variable influence of the environmental conditions occurring in different years. The captures of Sparus aurata and Dicentrarchus labrax are on average 250,000 and 150,000 respectively; the grey mullets demand averages 5 millions (40% Liza ramada, 30% L. saliens and L. aurata respectively) (Rossi, 1981a, 1981b).

4. CONCLUSIONS

A throughout discussion on the significance and the limits of this type of fishing in this area and elsewhere is out of the scope of this note. The analysis is also limited by the inadequacy and sometimes non-availability of data. In the next future it is hoped that the artificial reproduction will reduce the fish fry fishing. At present it is necessary to optimize the exploitation of this biological resource, at least by improving the harvesting, stocking and transport techniques.

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TABLE 1 - Number (x 1000) of fish fry harvested in the Southern part of the Po River Delta.

	<u>Sparus aurata</u>		<u>Dicentrarchus labrax</u>		<u>Mugilidae</u>
	N	N/boats	N	N/boats	N
1976	215		135		5000
1977	185		150		5000
1978	476	14.0	124	3.7	4767
1979	146	5.2	89	3.2	2752
1980	750	32.6	198	8.6	5063
1981	219	10.4	10	0.5	1787
1982	400	11.8	294	8.6	4380

ANNEXE KK / APPENDIX KK

Characteristics of trawl fishery in the coastal area of the Northern Adriatic

by

L. Fiorentini, G. Fabi, C. Frogia, S. Giannini and M.E. Gramitto
Istituto Ricerche Pesca Marittima, (C.N.R.) - Ancona, Italy

1. INTRODUCTION

Alpine rivers outflow and shallow grounds make the Northern Adriatic sea an area of very high productivity. Thermohaline conditions also make the North Adriatic environment and its ichthyofauna quite different from that of other Mediterranean areas. For all these peculiarities the nearshore area of this sea contains a rich ichthyofauna showing several analogies with that of the North Sea. The presence of important quantities of fish, spawning or overwintering adults and juveniles, stimulated over the years the development of a particular trawl fishery. The Italian law on marine fisheries (D.P.R. 2/10/1969) forbids trawling activities within the 3 miles from the shore, where depths are less than 50 m; but for a long time such activities were allowed in some North Adriatic districts by local authorities.

Biological investigations carried out in the inshore areas off Fano (Piccinetti, 1971), off Po river delta (Frogia and Magistrelli, 1981), off Marano lagoon (Frogia, Orel and Vio, 1979) and in other Adriatic areas (Frogia and Orel, 1979) evidenced the concentration of juveniles of many important species in summer months and, in the Northern Adriatic, the existence of three main fishing seasons:

Summer: juveniles of spring-spawners such as red mullet (Mullus barbatus), cuttlefish (Sepia officinalis) and squid (Loligo vulgaris) are abundant on coastal nursery grounds.

Late fall and winter: few species remain in the near-shore area, but important concentrations of sand smelt (Atherina boyeri) and flounder (Platichthys flesus) are present, especially off lagoons and rivers mouths. As a rule in this period no juveniles, except for black goby (Gobius niger) and anchovies (Engraulis encrasicolus), are present in the area.

Spring: Cuttlefish move from the offshore wintering grounds to the coastal waters, to spawn. From April to June this species forms the bulk of the catch for fishermen working with bottom-trawls as well as gill-nets or pots.

The above mentioned research proves that in nearshore waters of the northern Adriatic, in winter months a controlled trawling activity may result in an important production of some species without risks to compromise other stocks. On this ground, a new regulation of trawling was enforced in 1978. Quite soon social and economic evaluations overcame scientific results and fishing period, as well as fishing effort (limits on engine power of authorized vessels) were considerably enlarged. At the same time a licence system was adopted and the authorized fishermen were requested to report monthly catches obtained within the 3 miles zone. The quality of the informations received was extremely heterogeneous and a regular flow of reports was received only one-two months after the beginning of the fishing years. In 1982 catches began to be reported in a standard format, proposed by the IRPEM of Ancona. For the fishing years 1980-81 and 1981-82 we altogether received 10104 monthly reports; 5129 were positive representing 41165 fishing days. Unfortunately not all the fishermen gave catches sorted by main species for every single fishing day. Moreover the concept of "main species" was subjective, leading to some incomplete or false reportings. Well aware of the limits of the reports, we decided not to waste their potential informations and all available data were transferred, in a coded form, on magnetic tape to be further processed in the Institute computer. This report gives characteristics of the fleet involved, its seasonal activity and a preliminary analysis of catches.

2. CHARACTERISTICS OF THE FLEET

Licensed trawlers were divided into three categories on the basis of their engine power, considered an "index of effort" (less than 101 HP, between 101 and 150 HP, over 150 HP).

In the northern part of the area (Trieste - Chioggia) trawlers of the classes "over 100 HP" form the main part of the fleet licensed to trawl within the 3 miles area (Figure 1). Smaller boats "below 101 HP" prevail in the southern part (Ravenna - Rimini). Observed differences originate mainly from local fishing traditions and ports characteristics (i.e. several ports of Rimini district are shallow). For each district, the characteristics of the licensed fleet were compared to those of the whole fishing fleet, as recorded by the PESTAT survey of the Italian fishery and checked on the harbour-offices registers of boats (Table 1).

In the area between Trieste and Venezia a small percentage of boats "below 101 HP" work with bottom trawl; gill-nets and fyke-nets are the gears mainly employed at sea and in lagoons.

The average power of licenced trawlers is 196 HP at Trieste - Monfalcone and 116 HP at Venezia. At Chioggia 54 percent of the registered boats of the class "101-150 HP" are licenced to trawl into the 3 miles area. In the southern part (Ravenna - Rimini) of the area considered, fishery with fixed gears is not so developed and the licenced boats belonging to the smallest class "below 101 HP" make up 47 percent of the whole fishing fleet. For Rimini and Ravenna only 23 percent of the trawlers in the "over 150 HP" class result authorized to work within the 3 miles area.

Table 1: Percentage of trawlers licensed for coastal trawling as referred to the HP category and to the whole fleet in the considered district (1980).

District	Power class			Whole fleet
	HP $\leq$ 100	100 < HP $\leq$ 150	HP > 150	
Trieste	0	0	62	3
Monfalcone	3	60	72	20
Venezia	15	37	56	22
Chioggia	15	54	29	22
Ravenna	58	76	34	55
Rimini	69	65	16	57

Differences among districts were also observed in the percentage of utilization of licences during the fishing year.

All over the area a remarkable increase in the number of boats fishing inside the 3 miles area was observed in coincidence with spawning migration of cuttlefish; this phenomenon is particularly evident for bigger trawlers which, in other periods, find more rentable to operate on offshore grounds (Figure 2).

3. CATCH CHARACTERISTICS

On the basis of our previous knowledge of fishing activities in the area 14 species - or species groups - were selected to perform the analysis of catches: sand smelt (Atherina boyeri), flounder (Platichthys flesus), sole (Solea vulgaris), grey mullets (Mugilidae), sand gobies (Pomatoschistus spp.), black goby (Gobius niger), cuttlefish (Sepia officinalis), squids (Loligo vulgaris and Alloteuthis media), mantis shrimp (Squilla mantis), clupeoids (Clupeiformes), murex (Muricidae), scallops and queens (Pectinidae), Sphaeronassa mutabilis and Not Either Identified species. In this preliminary processing of data we used the cluster analysis to recognize main trawling activities during the authorized fishing year (October-June).

To minimize differences among trawlers of different size and to overcome limits of incomplete or false reports, for every considered day the absolute values were transformed into percentages of each species on the total daily catch.

The "K mean clustering analysis", supplied by the BMDP-79 (Dixon and Brown 1979), was preferred to the classical "hierarchical cluster analysis", keeping in mind the high number of days considered and the possibility to easily select the number of clusters.

The programme was runned several times increasing the number of clusters to be produced, untill further splitting of clusters already established appeared meaningless.

Eight clusters were produced and, from Table 2 and Figure 3, it results that the first seven clusters, each one identified by the species - or species group - most abundant in the catch, include 75 percent of the 41165 fishing days considered.

From a very preliminar analysis of results, some comments can be made. In the Rimini districts the catch is characterized during a few days only by sand smelt; this species is mainly landed in winter by small trawlers operating in the northern part of the district.

On the other side, in northern districts (Ravenna - Monfalcone) the catch is characterized by this species which is frequently associated with flounder in north-eastern part of the area during a high number of days, mainly again in winter.

In spring, during the few days when sand smelt dominates, catches of this species are reported by all trawlers of the smallest class, probably fishing very close to the shore in front of lagoons.

An important fishery for cuttlefish is evident all over the area in spring (Figure 3); in this period an increase in number of fishing days per boat and in number of trawlers working within the 3 miles area is evident for the whole fleet and more clearly among larger trawlers (Figure 2). The cluster analysis evidences also the existence of specialized fisheries limited to single districts.

A small fishery for grey mullets appears in Chioggia and Ravenna districts. Unfortunately during the fishing year 1981-82 the fishermen of the Goro Cooperative (Ravenna) did not record separately either grey mullets or clupeoids and this can explain the reduction of both these clusters in the second fishing year. In order to catch selectively this species, paired semipelagic trawl is mainly used. Trawlers fishing clupeoid fish with semipelagic nets extend their activity within the 3 miles area. The phenomenon is particularly evident in the northern part of Rimini district in spring.

Fishery for the small gasteropod S. mutabilis is restricted to the southern part (Rimini) of the investigated area. This fishery is quite important for trawlers of the smallest class. S. mutabilis is very abundant on fine coastal sands of the districts of Rimini and Ancona and can be harvested with small-meshed beam-trawls ("rapido"), the use of which within the 3 miles area is forbidden by law, or with baited pots. As a result of the low species detail in part of the reports, the cluster N.E.I. is very large (over 13 percent of fishing days considered). The "Unclassified" fishing days is also large (about 25 percent) and includes days with heterogeneous catches and days characterized by other different species.

4. CRITICAL REMARKS

At the beginning of our investigations the possibility of trawling within the 3 miles area was restricted to small trawlers and to winter months when sand smelt and sand gobies are the target species and juveniles of other species are very rare in catches.

As a result of subsequent extension of fishing period, and increase of fishing effort (engine power of authorized trawlers 100 HP maximum in 1978, 250 HP maximum or no limits in some districts in 1983, at present cuttlefish is the most important species caught.

Landings of cuttlefish at fishmarkets and percentages of fishing days with catch characterized by this species show an identical monthly trend in the spring season (Figure 4).

Despite the considerable increase of fishing effort in coastal areas, none of the considered species shows an increase in total annual landing. On the other side, in last years, landings of some species (i.e. S. mantis and A. boyeri) trend to decrease.

From spring to early autumn, coastal waters become populated by juveniles of several high priced species that may be endangered by the intensive trawling activity presently allowed till the end of June.

It is also worth noting that several species abundant in the area (S. officinalis, L. vulgaris, A. boyeri, G. niger, Pomatoschistus spp., S. mantis, S. mutabilis, Murex spp.) are spring-spawners with benthic eggs the survival of which may be endangered by a too intense bottom trawling. Also for this reason heavy trawling gears, like the Italian beam-trawl ("rapido") are forbidden by law within the 3 miles area. But some reports from fishermen demonstrate that such gears are regularly used.

From cluster analysis it turns out that also semipelagic trawls (cod-end meshes 12-18 mm stretched) are currently used. Lack of intensive controls results in a generalized use of small-meshed nets all the year round.

We believe that the present levels of trawling effort within the 3 miles area may threaten the existence of some stocks and reduce the possibility of work for fishermen using fixed gears (gill nets, pots, etc.) which activity - more selective, of lower disturbance to benthic environment and energy saving - has to be stimulated in the coastal zone.

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Table 2: Percentage species composition - mean and range (min-max) - of daily catches grouped in the 8 clusters obtained by the K mean clustering analysis.

Cluster number Species	1	2	3	4	5	6	7	8
<i>A. boyeri</i>	0.3 0.0-47.4	4.7 0.0-48.4	73.2 28.6-100.0	0.4 0.0-42.5	2.6 0.0-49.4	12.6 0.0-51.9	3.2 0.0-47.5	2.2 0.0-42.9
<i>F. flesus</i>	0.6 0.0-50.0	0.4 0.0-60.0	4.6 0.0-67.2	0.0 0.0-0.0	0.1 0.0-37.1	0.3 0.0-41.7	0.3 0.0-57.1	4.5 0.0-100.0
<i>S. vulgaris</i>	0.7 0.0-47.9	3.2 0.0-64.3	0.1 0.0-50.0	0.8 0.0-45.0	0.1 0.0-27.6	0.2 0.0-55.6	0.0 0.0-3.0	4.6 0.0-100.0
Mugilidae	0.3 0.0-50.0	0.5 0.0-50.0	2.1 0.0-51.2	0.2 0.0-45.1	1.8 0.0-50.0	0.7 0.0-51.6	89.0 40.0-100.0	1.2 0.0-44.4
<i>Fomatschistus</i> spp.	0.2 0.0-40.0	1.5 0.0-46.2	6.1 0.0-47.1	2.8 0.0-47.4	3.5 0.0-48.3	70.8 26.3-100.0	0.8 0.0-42.1	2.4 0.0-44.4
<i>G. niger</i>	3.4 0.0-42.9	0.5 0.0-46.2	2.4 0.0-54.7	3.5 0.0-50.0	3.2 0.0-51.9	1.8 0.0-53.8	0.0 0.0-0.0	22.9 0.0-100.0
<i>S. officinalis</i>	78.7 43.2-100.0	5.5 0.0-50.0	1.1 0.0-50.0	5.1 0.0-50.4	2.5 0.0-50.0	0.6 0.0-50.0	1.1 0.0-47.2	20.9 0.0-56.7
<i>L. vulgaris</i>	4.2 0.0-54.5	2.4 0.0-61.4	0.4 0.0-42.9	0.1 0.0-37.5	2.2 0.0-61.1	0.1 0.0-34.0	0.4 0.0-40.0	6.8 0.0-100.0
<i>S. mantis</i>	3.5 0.0-45.0	2.4 0.0-55.6	0.8 0.0-54.2	0.6 0.0-55.6	1.0 0.0-54.5	1.0 0.0-57.1	0.2 0.0-45.5	13.8 0.0-100.0
<i>Porex</i> spp.	1.2 0.0-56.3	0.3 0.0-49.4	0.2 0.0-38.9	0.0 0.0-0.0	0.0 0.0-0.0	0.0 0.0-0.0	0.0 0.0-0.0	2.0 0.0-100.0
Clupeoide	0.4 0.0-44.4	0.6 0.0-49.4	1.2 0.0-50.0	0.8 0.0-46.4	79.7 34.6-100.0	4.4 0.0-50.0	1.0 0.0-44.4	6.1 0.0-47.6
Pectinidae	0.0 0.0-38.7	0.0 0.0-57.1	0.0 0.0-7.6	0.0 0.0-0.0	0.0 0.0-0.0	0.0 0.0-0.0	0.0 0.0-0.0	0.3 0.0-100.0
<i>S. mutabilis</i>	0.9 0.0-49.5	0.9 0.0-50.0	0.2 0.0-50.0	83.7 38.5-100.0	0.5 0.0-50.0	3.0 0.0-50.0	0.2 0.0-42.9	2.3 0.0-45.5
Not Either Identified	5.6 0.0-48.3	76.7 35.7-100.0	7.6 0.0-51.2	1.9 0.0-48.2	2.8 0.0-50.0	4.4 0.0-50.0	3.8 0.0-48.4	9.8 0.0-50.0

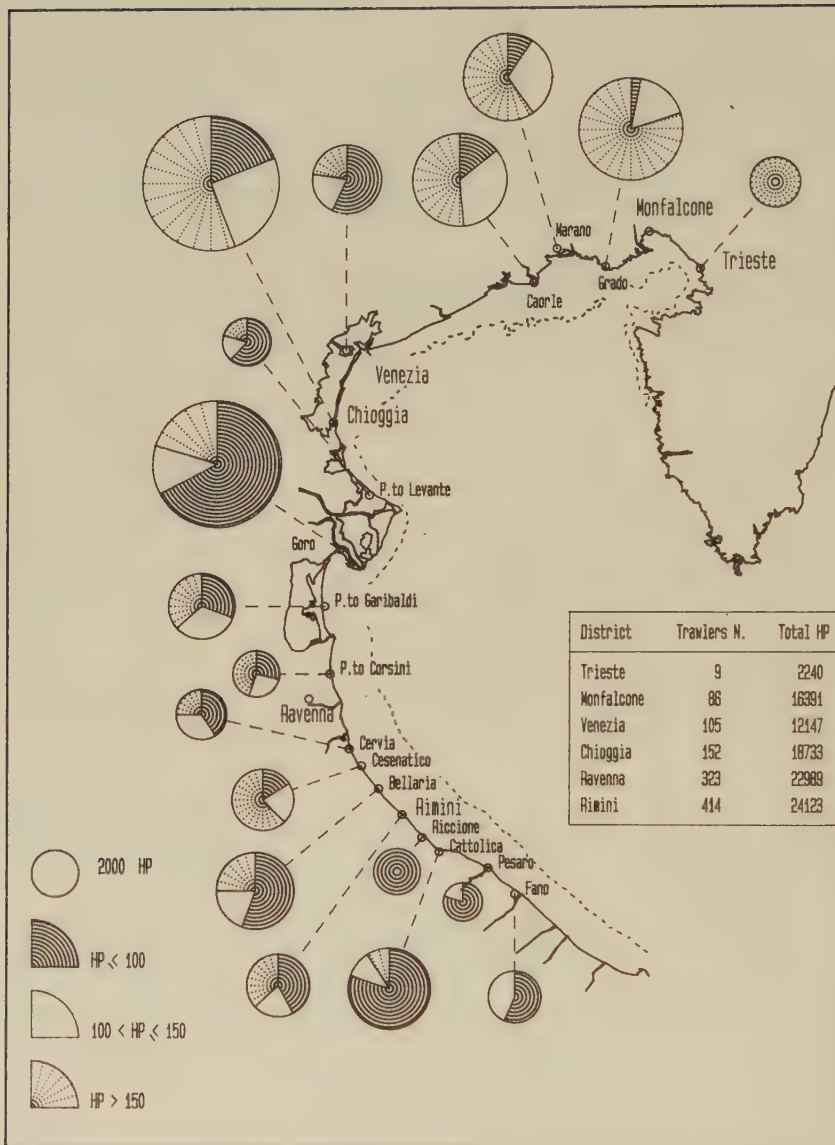


Figure 1: Distribution of effort (engine power) of licenced trawlers in the fishing season 1980-81.

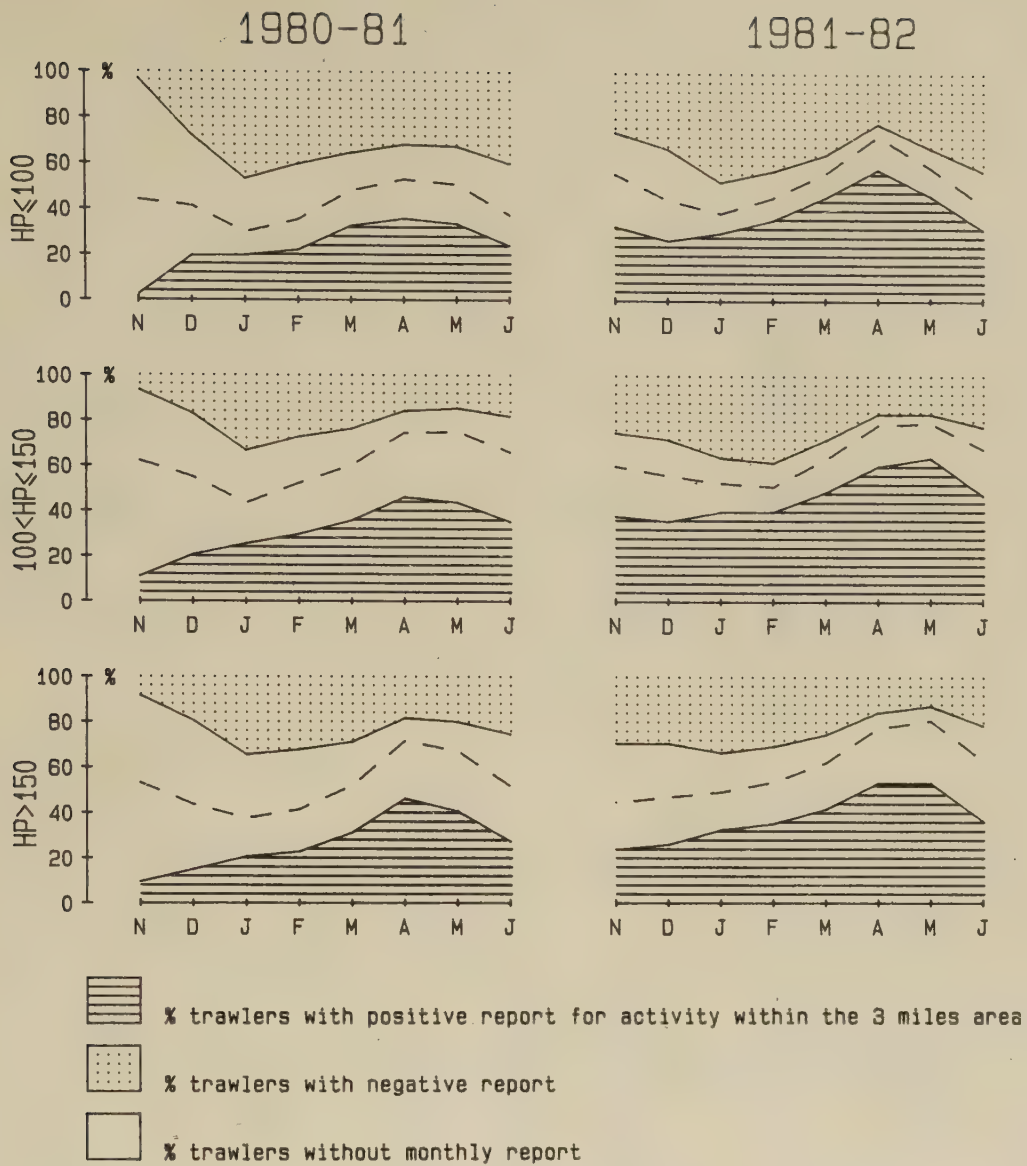


Figure 2: Monthly variations of percentage of trawlers fishing within the 3 miles area, estimated from positive and negative reports received.

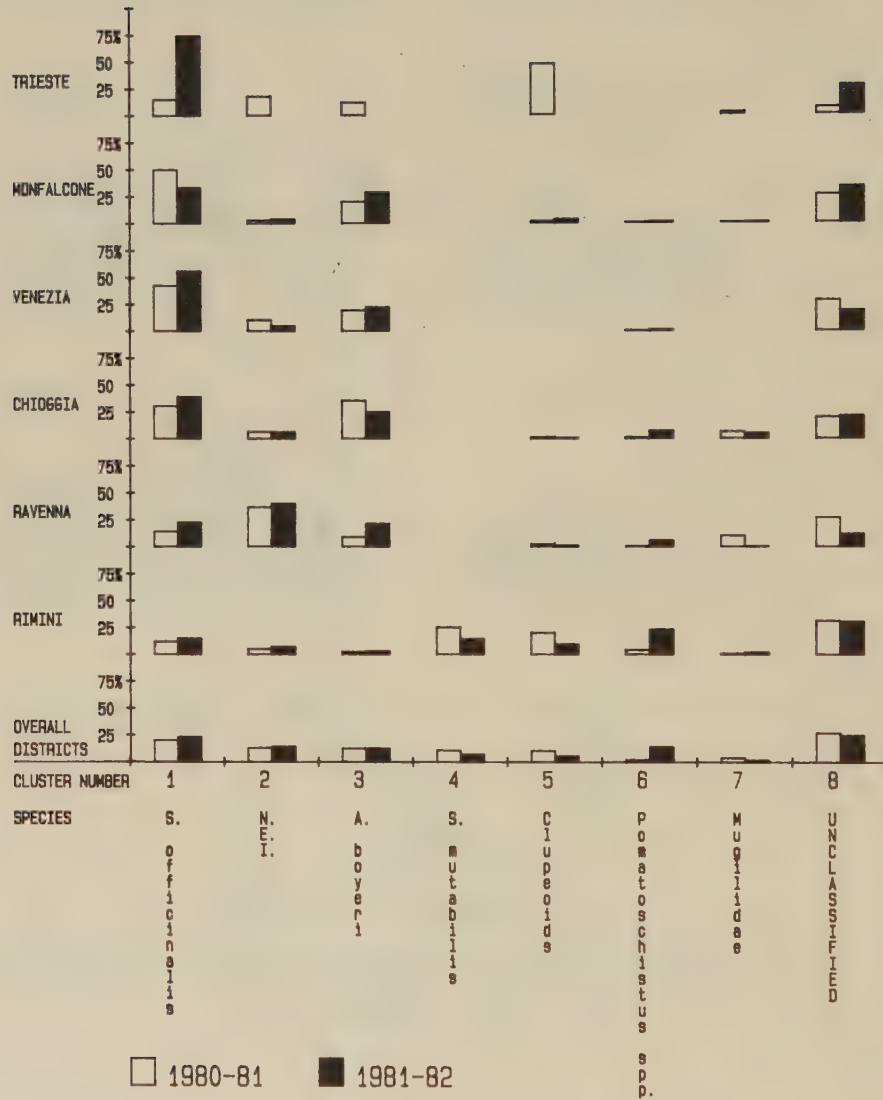


Figure 3: Results of the cluster analysis on daily catch composition. Percentage of fishing days in each district, assigned to each cluster in the fishing seasons 1980-81 and 1981-82.

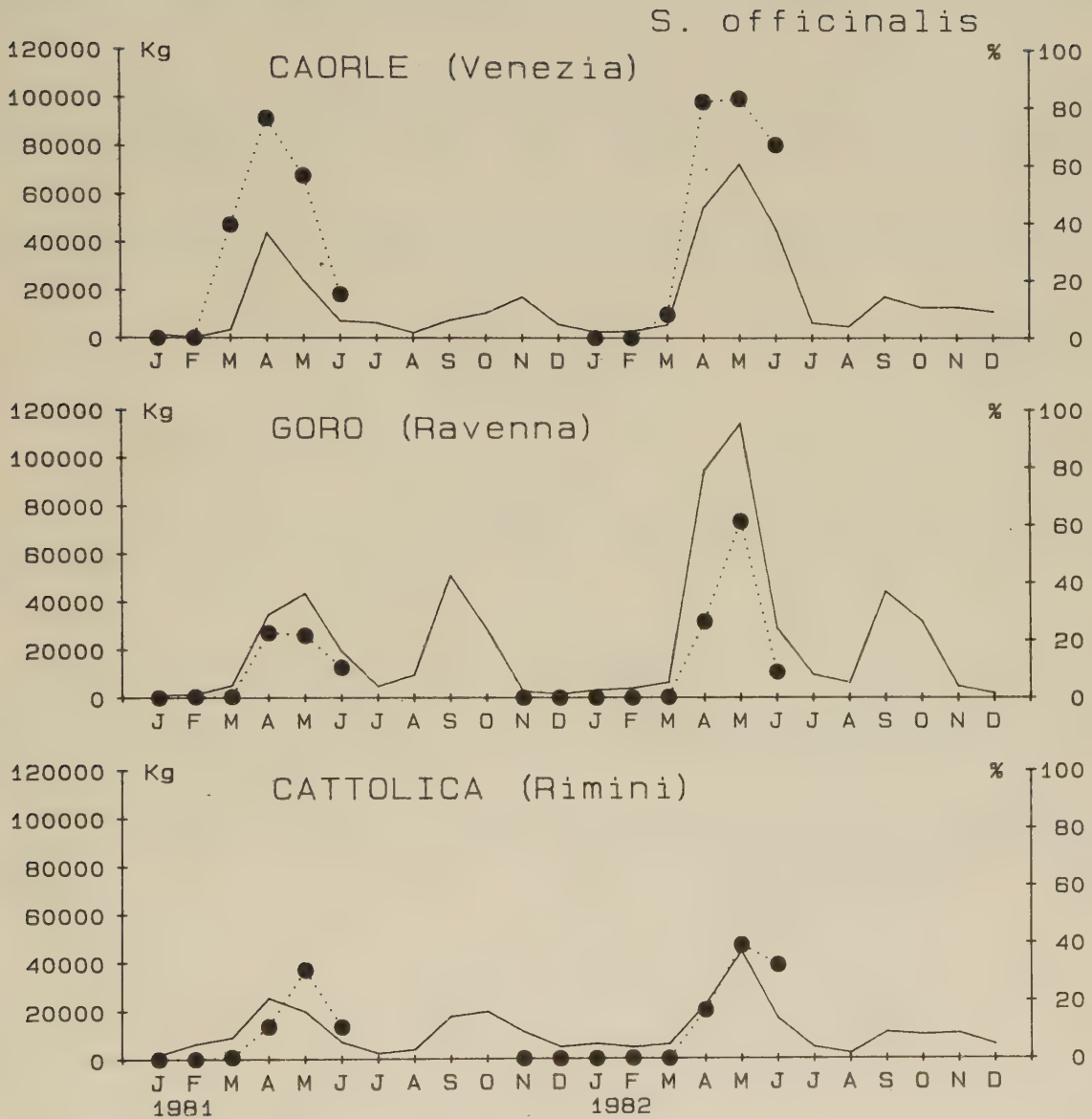


Figure 4: Landings of Cuttlefish in the years 1981 - 1982 in three selected fishmarkets (Caorle, Goro, Ravenna) and monthly percentages of days assigned to the "Cuttlefish cluster" in the districts of Venezia, Ravenna and Rimini.

ANNEXE LL / APPENDIX LL

One year trawling survey in the coastal area of the Gulf of Manfredonia

by

C. Piccinetti and O. Giovanardi
Laboratorio di Biologia Marina e Pesca - Fano, Italy

In 1982 trawling hauls have been carried out monthly at 0.5 (I), 2 (II), 3 (III), and 4 (IV) miles from the coast in the gulf of Manfredonia (Figure 1). Professional 120 H.P. trawlers equipped with the italian type "tartana" with a locally commonly used cod end opening mesh of 20 mm have been used.

Total (Figure 2) and specific (Table 1) cpue of the economically important Crustacea, Cephalopoda and all Pisces are represented; the table gives also indications on the presence of juveniles (under critical size or under the regulatory size limits), of sexually mature adults and identifies the species laying benthic eggs.

We have considered these aspects since the damages that the trawling activity can generally cause can be attributed to environmental changes affecting local biocenosis, specific food chains, etc. independently from the distances from the coast.

Most obvious effects can be summarized as follows:

- catching a lot of spawners may prejudice the following season recruitment (in case of species at low fecundity and limited coastal spawning area);
- injuring nest and benthic eggs;
- capture of juveniles and young specimens before they reach the critical size.

Other problems are the conflicting interests between fishing categories (small trawlers, fixed coastal gears, traps, etc.) and economic aspects linked to the coastal fishery: these problems are highly variable according to the zone.

Analysis of table 1 allows for a better definition and quantification of the real situation.

The presence of species at different stages of the biological -cycle, the variable distribution and spawning areas, the not quantifiable damage to the benthic eggs, the limited yields, the low commercial value of many species and in some cases the presence of spawners out of the prohibited 3 miles from the coast area (i.e. Gobius niger L.) would indicate a seasonally variable damage caused by the trawling activity.

Considering all aspects jointly we feel it necessary to limit the trawling activity in spring and summer; whereas it does not seem necessary to limit it in autumn and winter when the damage caused looks small.

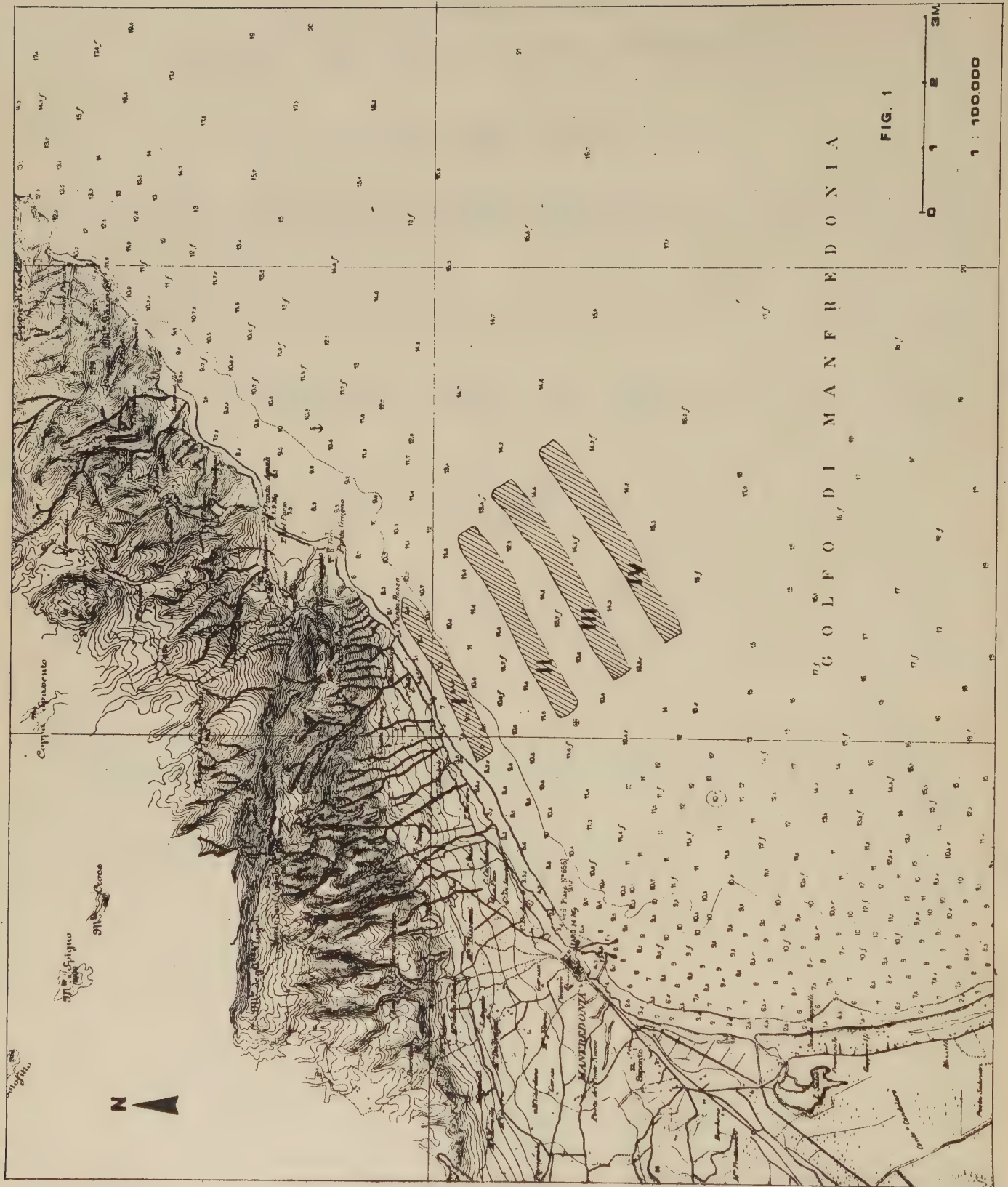


Figure 1: Trawling experimental areas in the Gulf of Manfredonia.

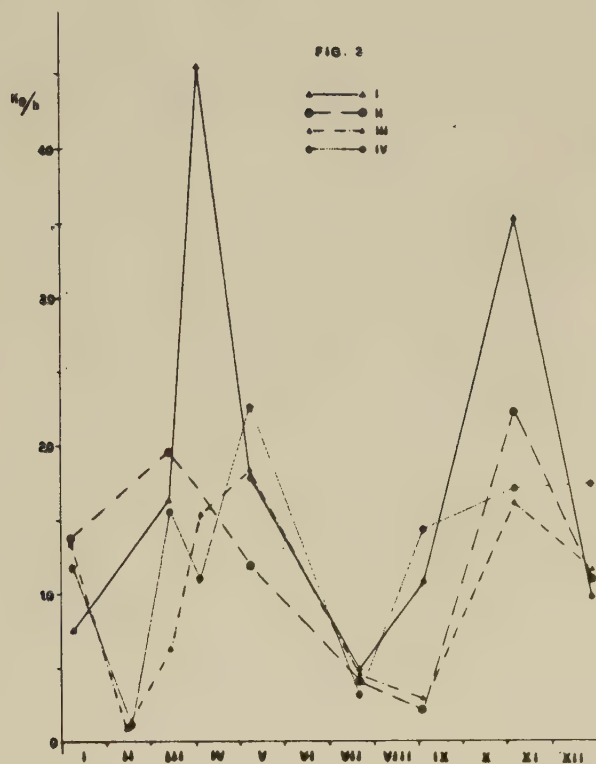


Figure 2: Seasonal variations of total catch rates.

SPECIES	9 JANUARY	13 FEBRUARY	13 MARCH	3 APRIL	7 MAY	20 JULY	4 SEPTEMBER	6 NOVEMBER	27 DECEMBER
	I I II III IV	I I II III IV	I I II III IV	I I II III IV	I I II III IV	I I II III IV	I I II III IV	I I II III IV	I I II III IV
* <i>Deltostoeus quadrimaculatus</i> (VAL.)	10! 1! 11!	24! 27! 27! 15	10! 6! 27! 32	8! 14! 10! 3	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	4! 1! 2! 1	65! 18! 37! 30
* <i>Pomatoschistus minutus</i> (PALLAS)	10! 1! 1! 1!	10! 4! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	50! 4! 7! 13
* <i>Pomatoschistus marmoratus</i> (RISSO)	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!
<i>Callionymus maculatus</i> RAF.	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!
<i>Callionymus rissio</i> LE SUEUR	1! 1! 1! 1!	2! 2! 4! 1!	3! 1! 9! 1!	6! 2! 8! 6	1! 1! 2! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!
<i>Stromateus fiatola</i> L. * < 120 mm.	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!
<i>Liza ramada</i> (RISSO)	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!
<i>Liza aurate</i> (RISSO)	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	5! 1! 1! 1!	1! 1! 1! 1!
<i>Liza saliens</i> (RISSO)	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	5! 1! 1! 1!	1! 1! 1! 1!
* <i>Atherina hepsetus</i> L.	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!
* <i>Atherina boyeri</i> RISSO	3! 2! 1! 4	22! 1! 1! 1!	8! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	2! 1! 1! 1!	87! 12! 5! 15
<i>Scorpaena notata</i> RAF.	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!
<i>Trigla lucerna</i> L. * < 150 mm.	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	2! 1! 1! 1!
<i>Scophthalmus rhombus</i> (L.)	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!
<i>Arnoglossus laterna</i> (WALB.) * < 68 mm.	39! 9! 44! 18	56! 48! 55! 30	23! 11! 55! 55	50! 30! 44! 19	4! 3! 5! 4	1! 1! 1! 1!	1! 1! 1! 1!	7! 13! 15! 14	7! 22! 15! 15
<i>Platichthys flesus italicus</i> (GUNTHER)	4! 1! 1! 1!	4! 2! 8! 1	1! 3! 3! 3!	2! 1! 7! 2	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	12! 2! 7! 7
<i>Solea vulgaris vulgaris</i> QUEENS.	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!
<i>Buglossidium luteum</i> (RISSO) * < 68 mm.	6! 2! 6! 8	28! 21! 17! 6	13! 7! 18! 17	44! 34! 53! 13	2! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	5! 13! 3! 6
<i>Monochirus hispidus</i> RAF.	6! 2! 1! 1	16! 7! 5! 2	5! 1! 1! 1!	5! 1! 4! 2	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!	1! 1! 1! 1!

N = indeterminate number of specimens;
 * = juveniles;
 = species; laying benthonic eggs;
 = presence of sexually mature specimens;
 I = haul at 0.5 M. from the coast; III = haul at 3 M. from the coast;
 II = haul at 2 M. from the coast; IV = haul at 4 M. from the coast;

Table 1: C.P.U.E. (no/h) per species. Upper line: adults, below: juveniles.

ANNEXE MM / APPENDIX MM

Mussel exploitation from natural beds and culture parks in the Sacca di Scardovari (Po River Delta)

by

Victor Ugo Ceccherelli
Institute of Zoology, University of Ferrara, Italy

1. INTRODUCTION

On the shallow, muddy bottom of the lagoons of the Po River Delta, *Mytilus galloprovincialis* Lamk. grows in natural subtidal beds (Ceccherelli et al., 1979). This is likely a special situation in Italy (very similar to that which occurs in the North European Wadden Sea) which makes economically profitable the fishing of mussels by means of a special kind of trawl net of about 1 m wide mouth.

Mussel fishing season in the Sacca di Scardovari starts in May and goes on usually till the end of September. During this period nearly the whole local fishery devotes itself to the mussel dredging and leaves it off when the daily catch is no more profitable. Particular areas where fishing is not allowed are chosen every year in order to permit the restocking. Moreover, the co-operative societies can determine a fixed amount of harvest per each member, usually 80-100 kg per day. At the beginning of the season, harvesting is carried out by means of forks and rakes on the shallow bottoms of the northern zone of the Sacca; later on all the grounds of the bay are exploited by means of the trawl-nets.

Besides mussel fishing, which at present contributes for the most of the total mussel yield of the Sacca di Scardovari, mussel culture is also practised in this bay. Cultivation is carried out according to the fixed suspended culture system (Korringa and Postma, 1957). Mussel seed (2 cm shell length) is collected in spring from rocks, stone dykes and breakwaters and made up into "ropes", which are suspended in parks, consisting of a fixed framework of wooden piles. Mussels of commercial size are generally harvested the next spring or early summer. During the raising period, mussels are periodically thinned out by splitting animals into two new ropes and eliminating fouling organisms at the same time. The so-called ropes consist of long bags of nylon net with variable mesh size (from 2 to 6 cm according to the animal size). These are filled with mussels which, as they grow up, pass out through the meshes and settle in compact mass around the nylon bags, which are reduced to mere suspending strings.

2. RESULTS

2.1 Mussel yield

Data on total annual yield for two different periods (1963-73 and 1979-82, respectively) are reported in Table 1. Similar data for the period 1974-78 are not at disposal because, owing to the mussel fisheries collapse following the 1973 cholera epidemic in Naples, both mussel fishing and cultivation were suspended for two years and afterwards resumed slowly without selling product through official market. Moreover only for the nearer period (1979-82) data are given separately for culture parks and natural beds. However, we could consider valid the same proportion between the two kinds of mussel yield also for the earlier period (1969-73). From data of Table 1, it is clear that, at present, about two thirds of the mussel yearly yield derive from fishing on natural beds and the remaining from fixed suspended culture.

2.2 Mussel bed production

Ceccherelli and Rossi (1981; 1983) monitoring a non-exploited mussel bed from 1977 to 1980, investigated the main characteristics of population dynamic and production of *Mytilus galloprovincialis* in the Sacca di Scardovari. The settlement of young mussels (1.5-2 mm shell length) on the bed is characterized by a main May-June abundance peak, which follows the main late winter (February-March) spawning of mussel populations of this region. The amount of recruitment, even if it is sufficient to support production, does not seem to be very large in comparison to that which occurs on hard substrata, owing to the unsuitability of incoherent muddy bottom to favour mussel settlement. Individual shell length growth, according to the Von Bertalanffy model, is fairly rapid and is the main factor upon which Scardovari mussel production is founded. In fact, mussels take about 14.5 months from settlement to grow to shell length of marketable size (50 mm). Dry weight shows wide seasonal variations mainly due to winter spawning and starvation. Specific mortality rate are higher for old, larger mussels, all the year round, and for all specimens during the spring-summer months.

Table 1. Values of mussel yield in the Scardovari Fishery (in tons).

Year	From culture	From natural beds	Total
1969	+	+	700
1970	+	+	650
1971	+	+	1880
1972	+	+	1490
1973	+	+	722
Harvesting and culture stopped in August 1973, owing to the cholera epidemic in Naples.			
1979	420	940	1360
1980	400	850	1250
1981	300	600	900
1982	600	1400	2000

+ separate data not available.

Table 2. Estimates of actual mussel production in a natural bed of the Sacca di Scardovari.

Year	Density of 0 ⁺ recruits at October (N m ⁻²)	Actual annual production (ash free dry flesh wt.) (kg m ⁻² y ⁻¹)	Actual annual production (live wt.) (kg m ⁻² y ⁻¹)	Maximum standing crop (ash free dry flesh wt.) (kg m ⁻²)	Turnover time (B/P 12) (months)
1977	1598	0.500	10.3	0.330	7.97
1978	977	0.305	6.2	0.202	7.96
1979	1695	0.531	10.9	0.351	7.93

Estimates of actual production in the bed for the years 1977-79 are reported in Table 2. They are underestimated values since they are referred to 0⁺ recruits surviving on the first autumn after settlement. They are, however, reliable as for harvestable production as they deal with specimens longer than 30 mm shell length. Yearly trend of production is mainly characterized by the fast turnover. In fact, about 8 months are needed to replace the observed maximum standing crop per unit of area (Table 2). Considering that fishermen harvest only mussels of commercial size (longer than 50 mm) the harvestable quota of the total yearly production can be estimated at about 29%. Both growth and production of mussel in natural beds of the Sacca benefit from the high food availability in the environment (Cavallini and Paesanti, 1979), but are hindered mainly by the excessive amount of suspended inorganic detritus coming from the deltaic branches of the Po River. That one interferes with mussels' efficiency in absorbing useful food and causes heavy mortality.

2.3 Mussel culture production

Growth, survival and yield of mussels in experimental cultivation ropes were monitored in the Sacca di Scardovari, from June 1978 to June 1979 to assess the effects of environmental conditions and thinning operations (Ceccherelli and Barboni, 1983). Shell length grows, on average, from 19.1 mm to 62.6 mm in one year. A negative influence of the amount of the suspended inorganic detritus can be observed from the different dry weight growth of molluscs cultured in more or less turbid waters. No growth advantages are obtained by increasing thinning frequency; survival, on the contrary, is strongly affected by thinning as a consequence of mussel losses, which increase when ropes are more frequently disturbed. At the best growing and thinning conditions, the harvestable yield of cultured mussels after a growth year reaches, on average, 0 458 kg ($SD \pm 0.064$) of dry fleshweight per 1000 seed mussels at cultivation start (9.4 kg of live weight).

3. DISCUSSION

Shell length growth of cultured mussels in the Sacca di Scardovari amounts to 43.5 mm per year (from June to June). In the same period mussels in natural bed grow, on an average, from 18.1 mm to 50.9 mm, i.e. 32.8 mm per year. This better growth of cultured mussels occurs mainly because animals filtering in a bottom bed get less food, owing to the higher concentrations of silt-clay detritus in the water layers close to the bottom (Ceccherelli and Rossi, 1983).

Cultured mussels yield 9.4 kg live weight per 1000 seed individuals per year, whilst mussel bed population gives only 1.9 kg of harvestable live weight per 1000 recruits per year. Cultured mussels production is higher by 5 times that of natural ones. On the contrary the contribution of cultured mussels to the total yield of the Sacca di Scardovari is only about 1/2 of that of fished ones (Table 1). Very probably, the mussel dredging cannot be much more increased. The co-operative society members themselves try, already now, to self-control the amount of daily mussel harvest and to respect some areas for restocking. Indeed, there is a limit to the spreading of mussel beds on those hostile, muddy bottoms.

On the contrary, the cultured mussels come, at present, from only 9 fixed parks, which cover, all together, an area of about 1 ha out of 3200 ha of the whole extent of the bay. If they were only doubled, the total mussel yield of Scardovari would increase by about 25%.

The easy catchability of bottom mussels in comparison with the costs of implantation and management of cultivation parks could explain the propension of fishermen of relying on the former kind of mussel exploitation. Notwithstanding, it is clear that the disproportion between the present levels of mussel cultivation and their production potential allows a wide margin to a further development of this mariculture practice in the Sacca di Scardovari.

It may be that the main problem which has to be solved to induce fishermen to invest capitals in mussel farming is to warrant the sure marketing of the product. At present, in fact, Scardovari mussel sale depends on private wholesalers because the local fishery does not yet have a shellfish purification plant, which is a necessity requested by the law, to be licensed to trade mussels on one's own account.

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